Mechanical World — October 1958

NEW ELEMENTS

THE proceedings at Geneva indicate an expectation among nuclear scientists that further new elements will be discovered to add to the already lengthening list. When the periodic table was first devised it became clear that there were elements which had not come the way of investigators. Deliberate search for them led to their being uncovered. Later, as knowledge of the structure of the atom was gained still further possibilities were revealed leading to the discovery of yet more elements. Now the nuclear explosion is believed to result in a whole gamut of strange forms; the present problem is how to capture. them.

It is extremely unlikely that conditions on this earth are suitable for the natural exhibition of all the elemental forms of the materials out of which the universe is built and the elements which are being added to the list are, so far as the earthly collection is concerned, very probably manufactured forms. As such they may have great applicational potentiality and further knowledge of them will be looked for with great interest, particularly in relation to nuclear technology.

OIL FOR ALL

A MORE startling report from the Geneva conference, and one which, by all accounts, attracted more than scientific interest, was the American proposal for a means of rendering available certain kinds of oil deposit. Tar sands and oil shales, if deeply seated, cannot have their fuel content extracted because it is not liquid and cannot be pumped out. It seems, however, that an underground atomic explosion might do the trick because of the liquefying effect of the great quantity of heat released. One can imagine other effects too if the process were not susceptible to complete control. Given the control, however, the prospect opened up is of almost any country having its own oil supply. That alone is sufficient to sustain interest in the project.

INDUSTRIAL GROWTH

THE growth of industry depends upon a recycling process whereby some of the value of the output is diverted to the nourishment of the technological body of the industry. This is not an old idea, strangely enough: the idea at one time was that capital was subscribed for a project, the means for carrying it out erected, and thereafter it just ran on and on as originally designed. There were people who discerned the expansive effect and used it, but most major undertakings were to all intents static, and the relics of some are still to be seen.

The contrast is found by working back historically from the most modern industries. The latter are self-rejuvenating to a major extent. Chemicals and oil are perhaps the best examples. In the oil industry no less than 60% of capital expenditure—and by far the greatest part of this comes from the industry itself—goes in exploration and drilling, that is in looking for the wherewithal to maintain and augment the product. In contrast, the extension of refining plant, which is more spectacular and strikes the popular eye, takes less than 20%, and the means of transportation—tankers, pipelines and the like—only about 7%.

DOWN TO EARTH

WITH so many scientific projects at the present time and so many of them concerned with getting away from the earth—as though the answer to everything lay in the beyond—it is salutary to be pulled up short by Professor Wager, who in his presidential address to the geology section of the British Association meeting made a strong plea for deep exploratory drilling into the earth. It is knowledge of the earth's crust as embodied in chemistry, metallurgy, and physics, which has promoted the great bulk of modern industry. In that respect only the thin skin of the crust has been explored. To go below, into the older regions seems so very obviously the thing to do that one wonders at first why it has not been done. The answer, of course, is illustrated by the work of the oil companies mentioned above—the very high cost, especially of going to the great depths proposed—of 10 kilometres and more. Still, in these days when so much is so readily spent on scientific work just for the chance of useful gain it seems to be a good gamble.

LOG SHEET

Long-welded Rails

New and higher standards of passenger comfort in railway travel are envisaged from British Railways' decision to install long-welded rails on main lines throughout the country as track renewals become due. Long-welded rails, which are made by welding rails together to form continuous lengths of a quarter-of-a-mile or more, greatly reduce noise and will give passengers smoother riding. The wheel rhythm characteristic of the standard 60 ft lengths of rail in general use will not be heard on the welded sections of line.

To accelerate the installation programme, four new rail-welding depots are to be established at Castleton (near Manchester), Dinsdale (near Darlington), Hookagate (near Shrewsbury), and at Motherwell, in addition to two existing depots at Chesterton Junction (near Cambridge) and at Redbridge (near Southampton).

Some 50 miles of British Railways have been equipped with long-welded rails and a further 60 miles will be installed by the end of this year. Some of the first major lengths will be laid in two three-mile stretches of the down main line of the East Coast route to Scotland, between Northallerton and Darlington, and between Newcastle and Berwick-upon-Tweed. It is estimated that about 170 miles of long rails will be laid in 1959 in replacement of existing track as it becomes due for renewal.

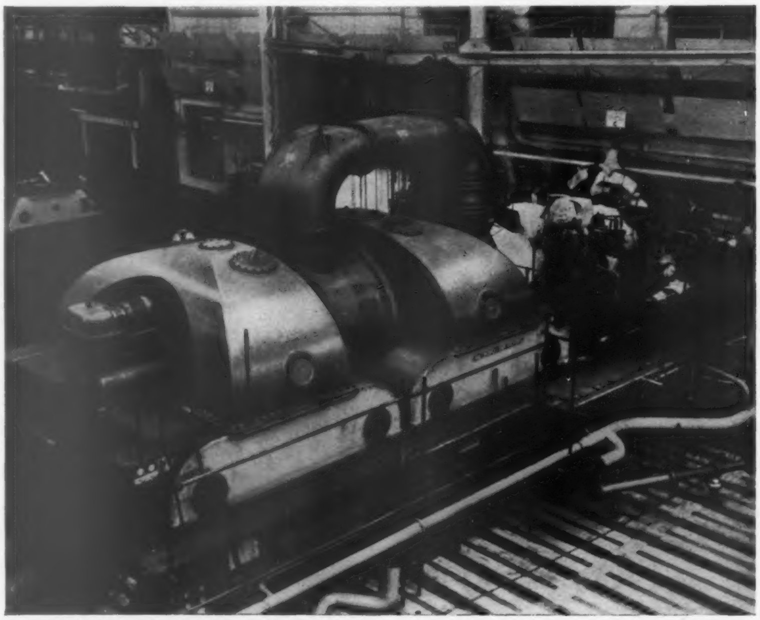
Long-welded rails are built up in the depots from 60 ft lengths of British Railways' standard flat-bottom rail, joined by the "flash-butt" welding method into lengths of 300 ft—a convenient length for transporting to the site where they are to be laid. When the 300 ft lengths have been positioned in the track, the ends are welded together to form continuous lengths of a quarter-of-a-mile or more.

An important contribution to further economies may be made by long-welded rails, as there are no rail joints (which account for some 25% of normal permanent-way maintenance) and rail-end failures are eliminated. Long-welded rails require a special technique in maintenance, and the full extent of the economies in installation and maintenance have yet to be established. Until now trial sections of long-welded rails have been laid in isolated stretches, and maintenance gangs have to maintain normal track on either side of the welded sections. To provide a suitable length of track upon which a complete work study may be carried out, both tracks of a five-mile stretch yet to be selected on the East Coast route will be re-laid with long-welded rails next year. The permanent-way maintenance gangs responsible for this section of the main-line will then be re-organised to determine the degree of maintenance required over a completely equipped length of track.

Most of the long rails installed in Britain are laid upon concrete sleepers using either a non-resilient clip which incorporates rubber between the clip and the rail to provide resilience, or a type of clip which is made of spring steel and is, therefore, resilient in itself.

Research has shown that the standard of track stability required for long-welded rails can also be achieved with timber sleepers, provided additional sleepers and suitable fastenings are used.

Long welded rails must be securely fastened to maintain the rectangularity of the framework of the track against buckling tendencies and to reduce the amount of movement at the ends of the length through expansion or contraction due to temperature changes. Adjustment switches have been used at the ends of the experimental lengths of long-welded track which have been laid in Britain to allow for the very small expansion movement which takes place over the last 300 ft at the ends of the long rails.



TURBINE TEST.—This 120-megawatt steam turbine seen under test at Metropolitan-Vickers' Trafford Park Works, is for the first of nine 120-MW generating sets being supplied by the company for power stations of the Central Electricity Generating Board. It will be installed at Blyth-A power station, which, when completed, will have in service four Metropolitan-Vickers 120-MW sets, supplied together with condensing plant, feed water heating and deaerating equipment

Isotopes Test Barrel Mixing

At the request of Dr. H. E. Zentler Gordon, metal finishing consultant, a series of tests using radioactive isotopes was recently carried out by the Isotope Division, Atomic Energy Research Establishment, Harwell at the Works of Roto-Finish Limited, Mark Road, Hemel Hempstead, Herts. The purpose of the tests was to determine the efficiency of mixing dry ingredients in a barrelling compound. It is believed that this was the first time radioactive isotopes were used to study mixing efficiency of these compounds in various types of

industrial mixers. Modern methods of preparing metal surfaces before finishing require fairly complex mechanical and chemical treatments so as to ensure good adhesion and durability of the metallic or organic coatings.

The proprietary compounds used in barrel finishing and metal cleaning may contain as many as ten ingredients ranging from old-fashioned but proved abrasives to the latest types of wetting agents and other compounds with specific chemical actions. Some of these are present in small quantities of the order of

"BACKBONE" GAS PIPE LINE.—This 16-in. steel pipeline is being laid across Hampshire and Berkshire to link the Southern Gas Board's main production centres at Southampton and Reading. The picture shows Fowler Challenger-3 tractors fitted with Marshall side-boom cranes being used by the contractors, William Press & Son Limited, to lay a section of pipe near Sutton Scotry. The line is being laid in this way at up to two miles a day

one or two per cent of the total mixture. Since the compounds are mixed in bulk and marketed in bags or drums it is important to ensure uniform distribution of the ingredients present in small quantities. Chemical analysis applied to the individual containers is obviously expensive if used for routine control; also it is not easily applicable to complex organic compounds.

The experiment at Roto-Finish Limited were carried out with two production machines handling batches of three hundredweights and six hundredweights respectively. The third mixer was a prototype for which basic performance data had yet to be obtained. For the two large mixers it

General view of mechanized plant for handling, cutting and drilling structural bars. All operations are under push-button control

was required to test for uniformity of mix half hundredweight units filled into cardboard barrels; some of these were tested further by taking four ounce samples from the top and bottom of the containers.

Of the dry ingredients used in the mixture it was decided to label the sodium carbonate. Sodium-24, the radioactive isotope formed by irradiation, has a half life of 15 hours, which means that the product will be safe for use within a reasonable length of time. After mixing under conditions of normal production the product was weighed into the barrels and placed on a measuring table. A ratemeter (type 1021) with associated scintillation head was used for all measurements. Whilst these tests were not intended to be exhaustive, the results obtained provided a satisfactory picture of the uniformity of distribution of an ingredient which was only 2% by weight of the total mixture. Thus, in the case of the three hundredweight production mixer, the maximum deviation from the average reading (in counts per second) was approximately 10% of the 2% active ingredient present. For the large six hundredweight mixer the maximum deviation from the average reading was less than 5% of the 2% active ingredient. In the case of the 4 ounce samples taken from the top and bottom of some of the barrels the maximum deviation from the average was within 20% of the 2% active ingredient which showed that even with quite small samples the uniformity of mixing proved satisfactory. The work was carried out by members of the Isotope Division, A.E.R.E., working in close co-operation with Mr. H. P. Evans, chief metallurgist, Mr. V. Wood, and Mr. F. Mimpress of the technical staff of Roto-Finish Limited. All instruments used, as well as the "activity" had been obtained from Harwell.

Mechanized Structural Plant

In 1953 there was installed at the Riverside Works of Boulton and Paul Limited, Norwich, an experimental plant designed by the company's works director, Mr. L. Measures. Boulton and Paul are structural engineers and the purpose of the plant was to eliminate template making and at the same time reduce the handling of steel bars. The plant was so successful that it was decided to market it and four are under way for British concerns and orders have been received from Canada and the United States.

The plant, which includes a Clifton and Baird sawing machine and Archdale drilling units, requires only four men for its press-button operation. Bars are moved by power under the saw and drilling heads and lengths and spacings are under accurate dial control.

P.N. Poles in Kuwait

British Insulated Callender's Construction Company Limited during the past two years have supplied some 800 P.N. poles to the Kuwait Oil Company. These have been used for the construction of about 55 miles of overhead lines on the distribution system which supplies the oilfields and associated installations in the State of Kuwait. The Kuwait Oil Company were the first customers to use the P.N. pole in any quantity, and experience gained in Kuwait has proved the suitability of these poles, which represent the most modern and economic form of overhead line support.

In the early stages of development the Kuwait Oil Company designed and fabricated their own overhead line supports, using steel pipes 6 in. dia. Now, however, that form of construction has been replaced by the P.N. pole, which has been standardized by the oil company for all light overhead lines operating up to 11 kV.

The design of this support takes into account the need for low cost, simplicity and ease of transport. It is built up from two side panels braced together to form an A-frame, the corner legs of which are fabricated from small bore steel tubing. All steelwork is galvanized.

The Kuwait Oil Company lines on which the P.N. poles have been used include the 10-mile long 11 kV line from Mina Al Ahmadi where the main steam power station of the oil company is located to Dhaba'iya, the residence of H. E. Shaikh Abdulla Mubarak. There is also a 20-mile long 11 kV line from Ahmadi to the water wells at Abduliyah from where most of the supply of brackish water for domestic use and other purposes is pumped to Ahmadi.

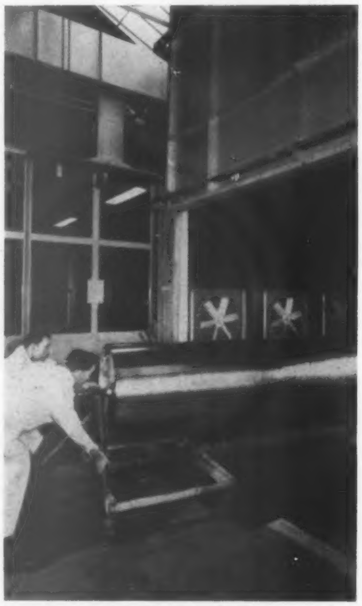
In the Burgan oilfields there is an 11 kV distribution system on P.N. poles comprising approximately 25 miles of line supplying a number of oil-gathering centres. Other lines supplied and erected by BIC Construction Company Limited include one 11 kV single circuit line on light Blaw Knox towers from the power station at Mina Al Ahmadi to the main substation in Ahmadi. This was the original transmission line from the power station to Ahmadi and was later supplemented by a 33 kV double circuit line on P.B. poles.

From Ahmadi outdoor switching station to the centre of the oilfields, there is a single circuit 66 kV line on P.B. poles approximately 12 miles long.

Both the P.N. and P.B. poles are fabricated and galvanized by Painter Brothers Limited, Hereford, with whom the BIC Construction Company Limited collaborated in the development of the poles.

PTFE Dispersion Coating

Polytetrafluoroethylene dispersion coating can be applied to articles of almost any size, and plant newly installed at the Tottenham factory of Siemens Edison Swan Limited includes ovens capable of accepting parts considerably bigger than a motor car, whilst conveyor ovens will handle large quantities of small parts.



A large textile roller coated with polytetrafluoroethylene, supported on a trolley, being wheeled into one of the sintering ovens

New applications for this process are being discovered daily and at present include the surfacing of rollers, moulds, hoppers, etc., used in the textile, papermaking, bakery, confectionery, plastics and chemical industries, whilst the company has been called upon recently to coat the inside surface of xanthating churns, used in textile manufacture.

Polytetrafluoroethylene, or P.T.F.E. has, in addition to excellent electrical characteristics, and heat and corrosion resistance, properties which are such that dispersion coating of articles results in a completely inert and non-stick surface with an almost zero co-efficient of friction.

The thickness of the coating varies according to the needs of the article being coated, i.e., resistance to abrasion, etc., but usually range from about 0·0005 in. to 0·004 in. Coatings of this order stand up to wear remarkably well and although P.T.F.E. is still comparatively expensive, the thin deposit which is usually adequate for most purposes renders treatment of quite large articles a very economical proposition.

Giant Smelter in Production

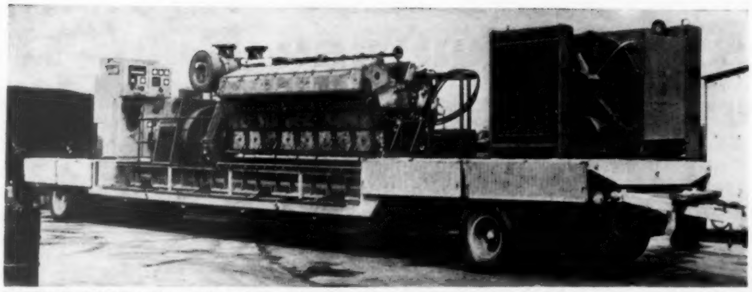
What will ultimately be the largest installation of multi-anode pumpless rectifiers in the world for the production of aluminium has reached the first stage of completion at the joint British-Canadian smelter which is being constructed at Baie Comeau in Quebec. The complete power conversion plant for stages 1 and 2 comprising transformers, rectifiers, switchgear and ancillary equipment including motors is being designed, made and installed by the British Thomson-Houston Company Limited.

Each furnace series, or pot line, required direct current of 100,000 amp at 850 volt. The smelting process is continuous and the electrical supply must therefore remain uninterrupted, consequently the plant is designed so that any portion of the equipment can be withdrawn from service for inspection or maintenance without reducing the power output.

The conversion plant is arranged in eight units, any seven of which can maintain the full output required for the pot line. Each unit consists of a single rectifier transformer—believed to be the largest of its type in the world—coupled to a bank of eighteen truck-mounted cubicle-enclosed Type MB pumpless steel-tank mercury-arc rectifiers. This form of enclosure provides a degree of protection and accessibility not generally found in Canada for equipment of this size. The transformers, apart from their size, are of interesting design and incorporate, as part of the main internal assembly, a phase-shifting transformer which enables 48-phase overall operation to be achieved with eight units in service.

BTH is responsible for the 33 kV switchgear, including standby circuits, and for the 13·2 kV system, with a considerable amount of low-tension switchgear. In the outdoor

switchyard the a.c. side of the transformers is controlled by type JB427 1500 MVA oil circuit-breakers. Protection on the d.c. side is provided by shelf-mounted Type RJR high-speed circuit-breakers. BTH has also supplied auxiliary transformers, power factor correction capacitors, metering, protection and control panels, oil-handling and treatment plant, and the substation ventilating system.



MOBILE GENERATING SET.—One of four large mobile generating sets designed for use in Venezuela, in townships and works where local permanent power is not yet available or is insufficient. There are two trailers to a set, one for the generator and one for transformers. The Mirrlees, Bickerton and Day engine is turbo-charged and has a continuous rating of 1727 hp at 900 rpm. Two Burgess snubber type silencers project through the trailer roof. Alarms are provided for lubricating oil high temperature and low pressure. Compressed air at 300 psi for starting, and at reduced pressure for pumping up the tyres, is provided by a Petter-Reavell petrol engine set. Cooling is by pumped water circulation through a Serck radiator, and lubricating is cooled by a Serck radiator. The engine has a Woodward hydraulic governor. The Brush alternator is rated at 1200 kW, 2400 V, 60 cycles. The transformer is a Brush 1500 kVA capable of converting full output from 2400 to 13,800 V

Sideways Ship Manœuvring

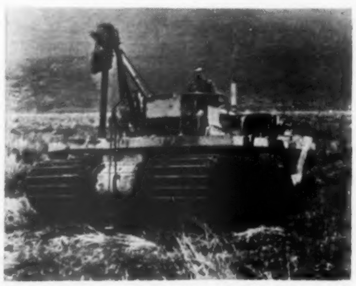
At the request of the Orient Steam Navigation Company Limited, Vickers - Armstrongs (Shipbuilders) Limited have devised a system of transverse propulsion which will be installed in the new liner *Oriana*. The equipment will facilitate the manœuvring of the vessel in confined waters, and by virtue of its instantaneous operation under direct control of the bridge, will greatly minimize the danger of damage to the vessel under these conditions.

The system consists of circular steel casings arranged across and through the vessel at the bow and stern at an appropriate depth below the waterline, and within these casings are fitted the propeller assemblies, which provide the propulsion effort. The Gill pump principle is the basis of the design. Both the bow and stern installations consist of two units which may be operated singly or together, and all units are remotely controlled from the bridge, where control pedestals are arranged in the centre of the bridge and also on either wing.

Largest "Water Buffalo"

First of its size, a giant Albion-Cuthbertson crawler tractor, known as the "Water Buffalo", was shipped recently to Shell Oil Company of Canada Limited, for use in oil exploration work in the Canadian Muskeg territory. Built by James A. Cuthbertson Limited of Biggar, Lanarkshire, the £10,000 tractor will be operating in an area which includes some of the worst swamp conditions in the world; but the extremely light ground pressure of approximately 2 psi exerted by its tracks, and other special features, will enable it to tow 30-ton loads of drilling equipment on a sledge-type trailer where vehicles a fraction of the weight could not operate.

An unusual feature of the equipment is its ability to lay out a cable to form a ropeway across particularly difficult swamps and, by means of special capstan winches mounted on the deck, to pick up the cable and haul the trailer over the worst stretches. The speed of the "Water Buffalo's" tracks are synchronized with that of the winches to give maximum tractive effort. It is also equipped with a cable operated bulldozer blade, and an A-frame at the rear for use as a crane. The tractor has a water-tight hull, and the top deck can be fitted with extension steel sides to make the machine buoyant, if it is later decided that the operating conditions make it necessary for the tractor to be amphibious.



First of its size, a giant Albion-Cuthbertson crawler tractor known as the "Water Buffalo", was shipped recently to Canada for oilfield use. The ground pressure is only 2 psi

The Water Buffalo is powered by a Leyland 150 hp direct-injection diesel engine with a torque of 450 lb-ft. It is equipped with the Leyland Pneumo-Cyclic semi-automatic gearbox and centrifugal clutch. The drive to the track sprockets is through a power divider and overhead worm gearing. The tracks are special Cuthbertson design 4-ft wide driven at the front end, semi-rubber, interlocking and flexible in all directions. The gross weight of the tractor is approximately 20 tons.

British Timken at Brussels

Many types of bearings are being displayed by British Timken Limited, of Duston, Northampton, at the Brussels exhibition, varying from a four-row rolling mill tapered roller bearing weighing 3½ tons, down to miniature bearings. The display is of a wide range of products which are used in all forms of transport and industry such as in cars, agricultural machinery, machine tools, rolling mills, aircraft, lorries and buses. Also included are railway wagon bearing units, railway axle and cannon boxes, and a sectioned propeller of the Viscount cut away to show the specially designed tapered roller bearings which British Timken supply for the Rotol propeller blades of this famous aircraft.

An interesting feature is the miniature bearings produced by Fischer Bearings Company Limited, a subsidiary of British Timken Limited. The smallest weighs approximately 1/1,000 ounce, whilst the largest bearing manufactured by British Timken Limited weighs over 4½ tons.

Bicera Research

The peculiar effect sometimes found in diesel engines and known as "water side attack" in which the water side of the liner and sometimes the inside of the jacket too becomes deeply pitted over well-defined areas, has been found to be due, in part at least, to vibration. This has come to light as a result of research now under way in the laboratories of The British Internal Combustion Research Association and is mentioned in BICERA Bulletin No. 8, for June.

Application and Heat Treatment of Plain and Alloyed Steels

Plain carbon steels constitute a group which is used probably more than any other. Providing they are correctly applied and their limitations recognised, very useful service can be obtained from them. On the other hand, there are many applications for which plain carbon steels are not suited and where alloyed steels must be employed. This article first deals with the application and heat treatment of plain carbon steels and then proceeds to consider alloyed steels and how the various alloy additions can be used to develop certain physical properties and give greater flexibility in heat treatment.

By A. G. GARDNER, A.I.M.

Plain carbon steels

THESE consist essentially of iron and carbon with the addition of certain small amounts of manganese, silicon and sulphur. They are classified according to carbon content and their application varies accordingly as the following list of typical uses will show:—

0·7% *carbon*.—Various types of battering tools, cold chisels, cold cutters, shear blades, punches, forging dies, hot rivet sets and keys.

0·8% *carbon*.—Blanking dies, chuck jaws, forging dies, shear blades, wire cutting pliers, and punches.

0·9% *carbon*.—Beading tools, cold heading dies, lathe centres, mining drills, pick points, punches, shears and wood working tools.

1·0% *carbon*.—Axes, arbors, bridge reamers, broaching tools, countersinks, cutlery, mandrels, blanking dies, and roll threading dies.

1·1% *carbon*.—Glass cutters, granite chisels, razors, lathe tools, reamers, taps and dies, and twist drills.

1·2% *carbon*.—Lathe-tools, drills and small cutters.

1·35% *carbon*.—Extra-hard planing, slotting and turning tools, drills, etc.

From these examples it will be seen that for certain applications steel of more than one carbon content can be used, but for many others there is one particular carbon content which should be specified.

When carbon steels are hardened in sections larger than about ½ in. they normally develop a hard case and a soft tough core. This composite structure is a valuable feature and often results in their preferred use over alloy steels.

Heat treatment

The operations of annealing, stress relieving, hardening and tempering will be discussed in that order. The user should first ascertain the carbon content of the steels which should have been chosen to suit the particular application as exemplified above. Carbon content is the all-important factor in deciding on the correct heat treatment and the appropriate temperatures quoted below should be used unless modified for a particular application.

Annealing.—The majority of material received from steel suppliers is already in the annealed condition, but annealing is often carried out after cold working to ensure grain refinement and to bring the steel to the optimum condition for machining and heat-treating. Thus, the objects of annealing are threefold:

(1) To soften the steel in order to assist machining.

(2) To relieve internal stresses arising from mechanical work.

(3) To produce a structure with an even response to heating.

When the formation of oxide scale is of no importance, carbon steels may be heated in any suitable furnace open to the atmosphere. However, if scaling is to be avoided the work should be protected by sealing in a container out of contact with furnace gases. As regards heating time, the material should be left in the furnace long enough to ensure heat penetration right to the middle of the section and approximately 15 min soaking time should be allowed for every inch or fraction of an inch of section. Thus a section thickness of 3½ in. would be given one hour's soaking time. It should be emphasized that by "soaking time" is meant time at temperature, since there is usually an initial fall in temperature when a load is first placed in the furnace.

The risk of cracking or distortion occurring during annealing or hardening can be lessened by preheating in a separate furnace held at a lower temperature of 450°—500° C. One of the most important factors in heating steel for any purpose is to bring the mass evenly to the required temperature. Starting with the furnace cold will achieve this and is often practised. These remarks apply particularly to large masses of steel which should be heated gradually, especially if of uneven section, as this allows thin and thick parts to heat up at nearly equal rates, thus avoiding thermal stresses.

After annealing, the rate at which the steel is allowed to cool will influence its hardness: a lower hardness being obtained from slower cooling. A suggested optimum cooling rate is 10°C per hour down to approximately 500°C, and this should result in a thorough anneal being obtained.

In the case of electric furnaces, cooling can be conveniently effected by either reducing or switching off the current and allowing the steel to remain in the furnace. From about 500°C to room temperature, cooling can be more rapid. A suitable annealing temperature for 0·7%

carbon steels would lie in the range of 760°—790°C, whilst for carbon contents between 0·8% and 1·2% the annealing temperature should be between 750° and 775°C.

Stress relieving.—Machining operations and other methods of cold working may induce stresses within the steel of sufficient magnitude to cause either undue distortion in hardening or brittleness after hardening. Although these conditions can be removed by the full annealing operation previously described, a stress relief at lower temperatures is sufficient and offers the advantage of avoiding the danger of decarburisation or excessive scaling. The steel should be heated uniformly to a temperature of 675°—725°C and allowed to cool naturally in still air. An air-circulation type of furnace is ideal for this operation, but other kinds can be used providing that heating can be carried out reasonably uniformly.

The relief of cold working stresses depends partly on time, and steel which has been given a large amount of cold working should be soaked for a relatively long time at the stress relieving temperature. On the other hand, minor stresses may be relieved in the short time necessary to ensure heating throughout the section. In order to avoid excessive heating time, the user should exercise his judgment based on the amount of cold working to which the material has been subjected.

Hardening.—The previous two sections have dealt with operations preliminary to actual hardening. It should, of course, be appreciated that, providing the steel is received in the annealed condition and no great amount of cold working is carried out, the user can proceed at once to the hardening operation about to be described.

The heating of steels for hardening can be carried out in lead baths, salt baths and semi-muffle or controlled atmosphere furnaces. Lead baths provide the most rapid heating rate, followed by salt baths. When using either of these latter methods, it is preferable to employ a preheating bath of about 650°C. Because of the rapid heating rate, the recommended hardening temperature should be increased by about 5°C unless the work is held in the bath for at least 15 min after the temperature has been attained. When a salt bath is used the recommended mixture is 56% potassium chloride and 44% sodium chloride.

When heating is carried out in a furnace, a slightly oxidising atmosphere should be employed. This can be roughly assessed by observing a small piece of charcoal placed in the furnace at the hardening temperature. The charcoal should appear brighter than the furnace wall for oxidising conditions. Excess air should, however, be avoided, and the supply be regulated so that the charcoal only glows slightly.

The heating rate and the time at temperature may slightly affect the properties of hardened carbon steels. In general, slower rates of heating, and soaking at the quenching temperature tend to increase the depth of hardness. Tools or parts of the same size and design should be given the same heating and soaking times so that uniform results are always obtained. Greater uniformity can also be obtained by oil quenching from about 870°C prior to hardening. When intricately shaped tools or dies are involved, a slow heating rate may be essential, since rapid heating would result in the temperature of some portions of the work being raised more quickly, with consequent deformation of the steel. For this reason lead and salt baths are not recommended for intricately shaped pieces.

Quenching should be carried out in such a way as to provide the most uniform cooling possible. The operator should bear in mind that the removal of the piece from the quenching bath while it is too hot is just as undesirable as to allow it to become too cold prior to quenching. Non-uniformity of cooling during quenching can cause cracking as a result of some parts of the work becoming cold whilst other portions are still relatively hot.

Brine or water may be employed for quenching, but brine is to be preferred since soft spots are then less likely to result. Brine should be made up by adding 13 oz of table or rock salt to each gallon of water. The hardening temperatures given in Table I are those usually recommended for plain carbon steels.

The temperature of the quenching medium will soon rise after a number of pieces have been quenched and an adequate cooling or circulating procedure should be adopted otherwise the efficiency of the quench will be impaired.

For large, solid tools, the temperature of the water should be about 10°C and for intricate articles, about 27°C.

Tempering.—The object of tempering is to relieve internal stresses set up in hardening, and to reduce the hardness in order to increase toughness. Relief of internal stress is affected by both time and temperature, and occurs more rapidly at higher than at lower temperatures. It is beneficial to hold the steel at the tempering temperature for a considerable time, and longer soaking is obviously necessary at the lower temperatures. In general, the minimum soaking time should be 1 hr for small sizes (½ in. and under) and for larger sizes the time should be increased. When the temperature is less than 160°C a minimum soaking time of 3 hr should be given.

Plain carbon steels are extremely hard in the as-quenched state, and are in a highly stressed condition. They should be heated very slowly for tempering, since too rapid a release of stresses can cause cracking. When it is impracticable to lower the temperature of the bath or furnace for the charging of material, the work should be preheated slowly by other means.

Table II shows the relationship between the tempering temperature and hardness of carbon steels. Although the figures relate to steel containing 1·0% carbon, the effect is approximately the same for all carbon contents from 0·8% to 1·3%.

The tempering of carbon steels within the range 230°—320°C should be avoided for certain applications as there is an apparent reduction in toughness.

Alloy steels

Although plain carbon steels are suitable for many purposes, they require a water quench to yield the desired

Table I.—QUENCHING TEMPERATURES FOR PLAIN CARBON STEELS

Approx. Carbon Content	Temperature range for Hardening
%	°C
0.7	800–830
0.8	780–800
0.9	775–800
1.0	760–785
1.2	755–775

Table II.—EFFECT OE TEMPERING TEMPERATURE ON THE HARDNESS OF 1% CARBON STEEL (Previously quenched in water from 780° C.)

Tempering temperature	Hardness
°C	Rockwell—C
100	67
200	63
300	56
400	49
500	39
600	28

degree of hardness. This drastic quench brings a great possibility of distortion and cracking, especially when the shape is rather intricate or large changes of section occur. Except in small sections, carbon steels after quenching in water for hardening generally give a hard outer layer whilst the core remains soft. As already mentioned, this is useful for applications where a hard case combined with a soft tough core is required, but when through hardening is desired this becomes a limitation. These difficulties with carbon steels are due to their critical cooling rate being very high, which means that the steel must be very rapidly cooled through its critical range if the hard martensitic condition is to be obtained. With plain carbon steels which exceed about an inch in thickness, it is difficult to obtain complete hardening throughout the section. When appreciably larger pieces are involved it is found that the cooling rates obtainable are so far removed from the critical value that the material is quite insensitive to heat treatment.

Most of the alloying elements used in steels reduce the critical cooling rate required for hardening and thus make it possible to use slower rates of cooling or, alternatively, to realise the fully hardened condition in large masses. It will, therefore, be appreciated that with the exception of the smallest sections, the use of an alloy steel is essential for through hardening. In addition to the advantage of a reduced critical cooling rate there are other reasons for employing alloy steels, and the position can be summarised by stating that alloy steels are desirable when one or more of the following conditions have to be met:—

(1) When intricate shapes have to be dealt with which, if hardened in water, would be liable to fracture due to the drastic quench of irregular sections.
(2) Where greater depth of hardening is necessary.
(3) Where it is essential to limit distortion or movement as the result of hardening or, as in the case of drawing dies, where a definite shrinkage is necessary to make good the loss of bore size due to wear.
(4) For tools subject to considerable heat in working.
(5) For tools where the maximum life is required and for work on such hard materials as heat-treated nickel-chrome steels, stainless steels, etc.
(6) When tools or parts must have the greatest resistance to friction or wear.
(7) In all cases where air, air blast or oil hardening is preferred.
(8) In any other instance where the best carbon steels correctly heat treated have failed to give the service required.

Alloy steels contain, in addition to carbon, a suitable percentage of one or more of the elements tungsten, molybdenum, vanadium, chromium, nickel, cobalt, etc. Although the number of these elements which finds extensive application as additions to steel is limited to about seven or eight, the wide range of carbon content, combined with varying amounts of one or more alloying elements, makes possible hundreds of different compositions for alloy steels. It is obviously beyond the scope of the present article to discuss each of the alloy steel compositions individually and therefore the main effects produced by the principal alloying elements will be discussed, together with applications.

Influence of alloying elements on hardening

The various alloying elements which are added to steel may be conveniently classified into three groups:—

(1) Elements which completely dissolve in the iron base or matrix. These additions usually give improved tensile strength and toughness of the steel.
(2) Elements which combine with carbon to form carbides. In this way increased hardness and tensile strength is obtained, but ductility is often reduced.
(3) A combination of (1) and (2), that is to say elements which partly dissolve in the iron and also form carbides. The general tendency of such additions is to improve both toughness and hardness as well as to increase tensile strength.

It is seldom that the addition of one alloying element alone will satisfy all requirements. A single element may give a number of positive results when added to steel, but as a rule it combines with other elements present to enhance effects which those elements alone will not provide so effectively. In dealing with the effects of individual alloying elements on steel, the above remarks should be kept in mind, since general as well as specific influences must be mentioned.

Before turning to alloying elements, some consideration should be given to the effects of the element carbon. This is the all-important factor: without carbon the quenching operation results in little or no hardening irrespective of what other alloying elements may be present. Carbon, therefore, determines the *intensity* of the hardening effect as compared with alloying elements which affect the *ease* with which hardening may be obtained.

When carbon content is increased within definite limits, it produces certain mechanical results which may be summarised as follows:—

(1) The ultimate strength and hardness are increased as a result of carbide formation, which is associated with a decrease in ductility and toughness. Dynamic or shock resistance is also lowered.
(2) Abrasion or wear resistance is increased, and this is reflected in a greater difficulty in machining.
(3) A lower hardening or quenching temperature can be used and a greater depth of hardening can be obtained, so that uniformity of hardness in large masses is improved.
(4) Fineness of fracture is enhanced.
(5) The steel becomes more sensitive to "hot-shortness" due to overheating for forging or rolling operations, with consequent reduction of service life.
(6) Thermal or heat conductivity is reduced.
(7) The steel becomes more difficult to weld.

The effects of individual alloying elements will now be dealt with approximately in order of their use and importance.

Nickel

(1) The ultimate strength and hardness are increased without any appreciable loss of ductility because the nickel dissolves in the iron matrix. Shock or impact resistance is improved.

(2) The cooling rate required for hardening is reduced and hardening temperatures are lowered. Heat treatment can, therefore, be simplified and a greater depth of hardening obtained. In consequence, less quenching deformation and less scaling occurs.

(3) Grain growth is retarded and the temperature at which its effects become serious is raised.

(4) In very high nickel steels of the Invar type the

thermal expansion has a low value, and this property offers advantages for precision instruments.

(5) Electrical conductivity is decreased.

(6) If nickel is present in amounts exceeding 12% the steels cannot be quench-hardened and are non-magnetic.

(7) When added in suitable amounts (7% to 25%) to high chromium (7% to 25%) irons and steels, nickel increases resistance to chemical attack at elevated temperatures. Since these alloys have good strength and toughness at high temperatures, they are usefully employed for furnace parts and in heat-treating equipment.

(8) Nickel and chromium are present in various combinations in structural steels and produce superior properties unobtainable with single element additions. The resulting alloy steels, which find wide application in engineering, have a higher ratio of yield point to tensile strength, greater hardness, and higher impact and fatigue resistance than the simple alloy types.

Chromium

(1) Ultimate strength, hardness and toughness are increased because of carbide formation and solution in the iron matrix.

(2) Higher hardening or quenching temperatures can be adopted. Chromium slows down the decomposition of the high-strength structure on cooling and ensures a greater depth of hardening with less drastic quenching. In fact, certain chromium steels can be hardened by air cooling. It can thus be appreciated why chromium has become an essential ingredient in high speed steels. Due to the higher hardening temperatures and deeper hardening properties of chromium steels they retain relatively high hardness with high tempering temperatures and high strength at elevated temperatures.

(3) Abrasion or wear resistance is increased. For example, steel which contains between 1·25% and 1·75% chromium with about 1·0% carbon is used for roller bearings, and stainless steels contain amounts up to 10%—16%, with carbon up to 0·5%.

(4) Graphitisation is prevented in high carbon steels. Additions of between 0·20% and 0·60% of chromium are made to high carbon tool and razor blade steels (1·15%—1·50% carbon) to increase hardness and prevent graphitisation.

(5) Both thermal and electrical conductivity are reduced.

(6) A greater resistance to chemical attack is obtained. Stainless steel containing 0·35% carbon and 13%—16% chromium is a typical example. It should be emphasised, however, that these steels must be suitably prepared and heat treated if they are to possess all the properties claimed for them.

(7) Chromium combined with nickel gives steels offering a wide range of useful properties, some of which may be noted here:

(*a*) Very high resistance to heat and high electrical resistivity.
(*b*) High tensile strength at elevated temperatures.
(*c*) High resistance to attack by strong acids and alkalis.
(*d*) Very little deformation or scaling at temperatures up to 1,100°C.

Tungsten

(1) The ultimate strength, hardness and toughness are raised as a result of the solution of tungsten in the iron matrix, also because of its strong tendency towards carbide formation.

(2) Grain growth is retarded and the temperature is raised at which this is likely to occur.

(3) Higher hardening or quenching temperatures can be used. The cooling rate required for hardening is reduced and deep hardening is obtained where the hardening temperature is sufficiently high to dissolve the tungsten and its carbides in the iron matrix.

(4) The tempering temperature is raised after hardening. Stability of the hardened matrix and carbides is partly responsible for the excellent cutting properties of complex alloy steels containing 8% to 20% tungsten. Maintenance of hardness at high temperatures is largely dependent on the amounts and ratio of tungsten and chromium. When additions of vanadium and cobalt are also made, the red-hardness properties of tungsten steels are greatly improved. These types of steel require to be heated, for hardening, above 1,000°C, and frequently above 1,100°C, to ensure that the maximum amount of carbide is taken into solution before quenching. In order to obtain maximum hardness and red-hardness properties, these steels should be re-heated, after hardening, to between 550° and 600° C.

Molybdenum

(1) Ultimate strength, hardness, and toughness are increased because molybdenum dissolves in the iron matrix; also because it has a strong tendency to form carbides. The ratio of yield point to tensile strength is raised and so is the reduction of area in the tensile test.

(2) Grain growth at hardening temperatures is retarded.

(3) An important property of molybdenum, when added to alloy steels, is that it intensifies the effects of the other major alloying elements. Among these indirect effects the following should be mentioned:

(*a*) The quenching temperature is raised.
(*b*) The transformation rate of the hard matrix is retarded so that deeper hardening can be obtained and an equal degree of hardness is produced by air or oil quenching of many alloy steels.
(*c*) The tempering temperature is raised after hardening with consequent greater stability of hardness at elevated temperatures.* Strength and creep resistance are also improved at these temperatures.
(*d*) Steels become less prone to temper brittleness and have very good resistance to impact and alternating stress.
(*e*) The addition of molybdenum to nickel-chromium steels improves machinability.
(*f*) Stainless steels are rendered more resistant to chemical attack by additions of 1·5%—2·75% molybdenum.
(*g*) Molybdenum assists the red-hardness properties in hot working steels. For this reason, molybdenum combined with chromium, nickel and vanadium is extensively applied in hot working tools and dies where dimensional stability is important.

(4) In general terms, it may be stated that molybdenum has a similar effect to tungsten but of a different magnitude: 1·0% of molybdenum being approximately equivalent to 2%—3% of tungsten.

Vanadium

(1) Ultimate strength, hardness and elastic ratio are increased as a result of the strong tendency to form a

carbide and also to dissolve in and strengthen the iron matrix. The resistance to shock impact and alternating stress is also increased.

(2) Grain growth is slowed down and the possibility of its occurrence, due to prolonged heating at hardening temperatures is reduced.

(3) Higher hardening or quenching temperatures can be used. The tempering temperature is also raised and the red-hardness properties of high speed steels employed for cutting tools is enhanced.

(4) Like molybdenum it intensifies the individual effects of the other major alloying elements.

Cobalt

(1) Cobalt dissolves in the iron matrix and brings about increases in density, strength and hardness.

(2) Higher hardening or quenching temperatures can be used.

(3) Cobalt constitutes another element which intensifies the effects of such other major alloying elements as nickel and chromium.

(4) Cobalt can be substituted for nickel in heat-resisting types of steels for the object of producing similar properties.

(5) In amounts up to 14%, cobalt stabilises the carbides of tungsten and chromium in high-speed tungsten steels.

Aluminium

Aluminium is used for degasifying and deoxidising molten steel during refining but distinct from this, aluminium has certain other advantages:—

(1) Grain growth is retarded and grain size can be effectively controlled.

(2) Density, strength and hardness are increased.

(3) In amounts between 1·0% and 1·25% aluminium is used in nitriding steels to facilitate the production of a uniformly hard and strong nitrided layer.

Other constituents of alloy steels

Manganese, silicon and sulphur are present in all steels, but normally only in very small amounts. For some purposes, however, they are added or occur incidentally in larger quantities, and their specific effects in these circumstances will now be described.

Manganese

(1) Ultimate strength and hardness are increased with only slight loss of ductility, within certain limits. This element dissolves in the iron matrix and also forms carbides.

(2) The depth of hardness is increased and the hardening temperature is lowered so that there is less tendency for scaling and distortion to occur.

(3) Wear resistance is increased, particularly with high carbon steels. Austenitic manganese steel (12% or more manganese and approximately 1·25% carbon) cannot be quench-hardened, but has the property of hardening as a result of cold working and consequently resists deformation and severe wear. This particular steel is difficult to machine, but finds application in grinding mills and rails.

(4) Grain growth, which results in lowered strength, can occur more readily if heating is prolonged at hardening temperature.

(5) Thermal conductivity is decreased so that more time is required for a piece of steel to become heated throughout to the hardening temperature. This applies only to steels in which manganese is appreciably in excess of that present in carbon steels.

(6) Electrical conductivity is decreased, especially when the manganese content exceeds 12%. Such steels are non-magnetic.

Silicon

(1) Yield point, tensile strength and hardness are increased, but to a lesser extent than by carbon and manganese, without much decrease in ductility for amounts up to 2·5%. Silicon in excess of the latter figure causes increased brittleness.

(2) The solubility of carbon in iron is decreased and silicon tends to cause the formation of undesirable free carbon (graphite) in high carbon steels, especially if the material is subjected to prolonged heating at hardening temperatures.

(3) Hardening or quenching temperatures are raised.

(4) Grain growth at hardening temperatures is increased.

(5) Greater forgeability or malleability is imparted to many of the complex chromium-nickel alloy steels (25% chromium, 20% nickel types).

(6) Silicon retards air-hardening of the chromium-tungsten and chromium steels used for the exhaust valves for internal combustion engines which are often subjected to operating temperatures which exceed normal hardening or quenching temperatures.

(7) Addition of 2%—3% silicon inhibits certain types of corrosion, oxidation and scaling at high temperatures of some stainless or corrosion resistant steels.

(8) Steels containing 1·25% to 4·0% of silicon find wide applications as transformer sheets in the electrical industry.

Sulphur

Additions of sulphur improve the machinability of free cutting steels. Free machining properties can be imparted to certain stainless steels and irons in this way so that production of components on automatics is facilitated.

Polythene Letters for Moulding Patterns

A range of polythene letters specially produced for use in moulding patterns are now available from Aldridge Plastics Limited 155, Charing Cross Road, London WC2. As with lead characters they are pliable and can be moulded to any normal contour with ease; glued or pinned without difficulty and are unaffected by water. In addition, polythene letters cost only half as much as lead characters: they are extremely resilient—direct hammer blows produce only instantaneous distortion—consequently the most rigorous hand or machine ramming is withstood without fear of burrs forming and subsequent damage to moulds on pattern withdrawal is eliminated. Also the inherent self-lubricating property of polythene completely overcomes any tendency to stick.

Polythene letters are normally produced in light grey to contrast with the conventional red, yellow and black used for pattern identification. The prices vary from 8d. per dozen for ⅛ in. letters to 3s. 10½d. per dozen for 2 in. letters.

Statistical Data on the Generation of Electricity in the United States 1940–1957

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., A.M.I.E.E., Consulting Engineer

During the past decade the progress in the generation of electricity has been remarkable. As this applies particularly to the United States it seems appropriate to consider the statistical data on the operating results of both steam and hydro stations in America. Such detailed information is presented in a number of tables and a series of graphs showing the yearly progress since 1940. However, the period 1948-1957 is to receive special attention. A comparison of certain specific values with those obtained for steam power stations in England and Wales has also been included for it should prove most instructive.

A summary of the statistical data of power stations in U.S.A. for the years 1940-1957 is indicated in Table I, which deserves close examination.

1. Units produced (1940-1957)

The yearly units produced in million kW hr are indicated separately for both fuel and hydro stations in columns 2 and 3 respectively of Table I, which also records in column 4 the total. The units produced are plotted year for year since 1940 in Fig. 1. During a period of ten years from 1948 to 1957 the total units produced in U.S.A. increased from 282,698 million to 632,564 million kW-hr, thus the increase was 2·238 times.

The units sent out from steam stations in England and Wales were 36,220 million in 1947-8 and 74,278 million kW-hr in 1956-7, the increase being 2·054 times, which is reasonably close to the American value. The maximum annual increase for England and Wales was 13·52% in 1950-1 and the lowest 3·639% in 1952-3. In 1957 the U.S.A. produced 8·502 times the units sent out from steam stations in England and Wales. The hydro stations generated 20·32% of the U.S. total.

2. Installed capacity

The installed capacity at the end of each year in MW is indicated for fuel and hydro stations in columns 5 and 6 respectively of Table I, with the total shown in column 7. The values are plotted in Fig. 2. The total installed capacity was 56,560 MW in 1948 and 128,800 MW in 1957 representing an increase of 2·275 times or 125·5% in ten years. The annual change in the installed capacity for both fuel and hydro stations and the total are summarised in Table II. On the basis of the total installed capacity, the maximum increase was 12·1% in 1954 an the minimum 0·4% in 1946.

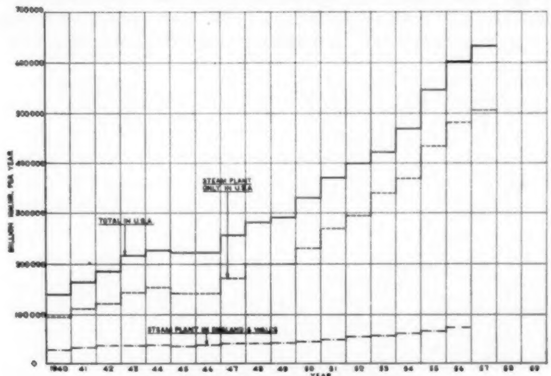


Fig. 1.—Units in million kWhr per year

The installed capacity for England and Wales was 10,253 MW in 1947–8 and 20,481 MW in 1956–7, i.e. an increase of 1·997 times or 99·7%. In 1957 the total installed capacity of American stations was 6·29 times that for England and Wales.

3. Capacity Use Factor

This is expressed in kW hr per kW of average capacity and is indicated in columns 9, 10 and 11 of Table I for

Table I.—STATISTICAL DATA ON POWER STATIONS IN U.S.A. 1940-1956

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Million kW hr. produced			Installed capacity at end of year in MW				kW hr. per kW of average capacity			New addition of plant		Net addition of plant		Average coal consump-tion
	Fuel	Hydro	Total	Fuel	Hydro	Total	Fuel % of total	Fuel	Hydro	Total	Steam only	Total steam & hydro	Steam only	Total steam & hydro	
											MW	MW	MW	MW	Lb./kW
1940	94516	47321	141837	28703	11224	39927	71.9	3342	4258	3600	—	—	—	64	1.34
1941	173925	50863	164788	30588	11817	42405	72.1	3843	4415	4003	—	—	—	2478	1.34
1942	122109	63871	185979	32211	12842	45053	71.5	3889	5180	4253	—	—	—	2648	1.30
1943	144127	73632	217759	34067	13884	47951	71.0	4389	5510	4683	—	—	—	2898	1.30
1944	154244	73945	228189	34603	14586	49189	70.3	4492	5195	4698	—	—	—	1238	1.29
1945	142516	79970	222486	35199	14912	50111	70.2	4078	5422	4481	—	—	—	922	1.30
1946	144772	78406	223178	35468	14849	50317	70.5	4097	5269	4445	—	—	—	206	1.29
1947	177313	78426	255739	37351	14971	52322	71.4	4870	5260	4983	1835	2147	1722	2005	1.31
1948	200228	82470	282698	40908	15652	56560	72.3	5052	5386	5193	3197	4183	3269	4238	1.30
1949	201351	89748	291100	46446	16654	63100	73.6	4610	5561	4865	5356	6611	5336	6540	1.24
1950	233203	95938	329141	51244	17675	68919	74.4	4774	5589	4986	4693	5803	4692	5819	1.19
1951	270922	99751	370673	56907	18868	75775	75.1	5010	5460	5123	5670	6968	5333	6856	1.14
1952	294121	105102	399224	61807	20419	82226	75.1	4955	5350	5054	4892	6457	4814	6451	1.10
1953	337432	105233	422665	69457	22045	91502	75.9	5141	4957	5096	7803	9521	7556	9276	1.06
1954	364617	107069	471686	79382	23211	102592	77.4	4899	4732	4860	10287	11532	9867	11090	0.99
1955	434063	112975	547038	89468	25004	114472	78.2	5141	4686	5040	10383	11970	10010	11880	0.95
1956	478639	122029	600668	95043	25654	120697	78.7	5188	4818	5108	5288	6275	5351	6335	0.94
1957	503968	128596	632564	101740	27060	128800	79.0	5122	4879	5071	—	7533	6875	8103	0.93

fuel and hydro stations and the totals respectively. The values for steam stations (col. 9) are shown graphically in Fig. 3.

4. Yearly increase in the capacity of plant

The new and net addition of steam and the total of steam and hydro stations are recorded in columns 12 to 15 inclusive of Table I. The net addition of steam and hydro stations was 4238 MW in 1948 and 8103 MW in 1957. The annual increase in the new addition to the capacity of steam plant and the total of steam, hydro and internal combustion engines is shown by the graphs in Fig. 4. The planned additions of the capacity for the years 1958, 1959, 1960 and after 1960 are shown in Table III and plotted in Fig. 4. These values are based on the "Electrical World" survey. It will be observed from this Table III that it is planned to add 16,663 MW in 1958, 13,769 in 1959, 12,121 MW in 1960 and after 1960 the estimated value is 20,251 MW. The new generating plant commissioned in England and Wales was 423 MW

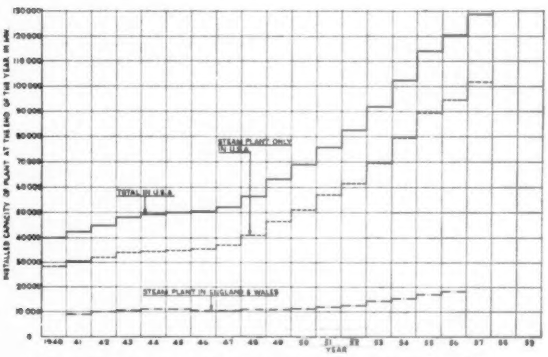


Fig. 2.—Installed capacity of plant at the end of each year in MW

in 1948–9 and 1783 MW in 1956–7, which represents the maximum yearly increase.

5. Yearly coal consumption

This is shown for the years 1941 to 1957 in Table IV, either expressed in million tons or in lb/kW-hr. The lowest yearly average so far obtained from all steam stations was 0·93 lb/kW-hr in 1957. In that year 162·04 million tons of coal were burnt. For the steam power stations in England and Wales the coal consumption was 42·539 million tons and the lowest yearly average so far obtained was 1·281 lb/kW-hr in 1957. This is 27·7% higher than the American average and indicates clearly that the large

Table II.—ANNUAL CHANGE IN INSTALLED CAPACITY ("Electrical World", 27.1.58)

Year	Fuel Station	Hydro Station	Total
	%	%	%
1941	6.6	5.3	6.2
1942	5.3	8.7	6.2
1943	5.8	8.1	6.4
1944	1.6	5.1	2.6
1945	1.7	2.2	1.9
1946	0.8	Nil	0.4
1947	5.3	0.8	4.0
1948	9.5	4.5	8.1
1949	13.5	6.4	11.6
1950	10.3	6.1	9.2
1951	11.1	6.7	9.9
1952	8.6	8.2	8.5
1953	12.4	8.0	11.3
1954	14.3	5.3	12.1
1955	12.7	7.7	11.6
1956	6.2	2.6	5.4
*1957	7.0	5.5	6.7

* Estimated.

difference is due entirely to the majority of British plants operating at much lower pressures and temperatures.

6. Operating conditions

It must be fully appreciated that an initial pressure of 2,300 psig was first introduced at the Twin Branch station of the Indiana Michigan Electric Company. This two-shaft machine of 76,500 kW was started up in 1941 and was designed for 2,300 psig at 940°F with reheating at 400 psig and 900°F, a vacuum of 29 in. Hg at 30 in. Hg

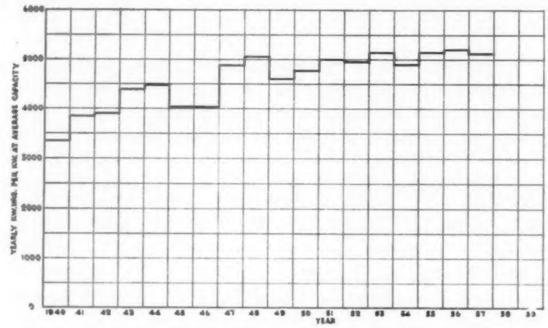


Fig. 3.—Yearly kWhr/kW at average capacity of steam stations in U.S.A.

barometer, and a final feed temperature of 490°F. It must be emphasized that the temperatures for American steam plant increased rapidly, i.e. to 1,000°F in 1947, to 1,050°F in 1948 and 1100°F in 1953.

It is of particular interest to compare the above operating conditions with those used in power stations in Great Britain. The first steam turbines to be commissioned in Great Britain, operating at 1,500 psig and 1050° F were the 60 MW sets installed at Drakelow in 1954 and Meaford B in 1955. These were then followed by the six 100 MW units at Castle Donington designed for the same initial steam conditions.

7. The net thermal efficiency of American stations

According to the 1955 heat rate report by the Federal Power Commission Survey, there were 10 stations operating at a net thermal efficiency above 36·41%, 20 stations above 35·45% and 45 stations above 34%. The list of net heat consumptions and the net thermal efficiencies of the 15 most efficient steam plants in the U.S.A. in 1955 is presented in Table V. The highest

Table III.—ADDITIONS OF CAPACITY IN MEGAWATTS ("Electrical World", 27.1.58 pp 94 and 119)

	1958	1959	1960	After 1960
Hydro	3,103	2,987	2,178	10,394
Steam	13,504	10,757	9,925	9,828
I.C.	56	25	18	29
Total	16,663	13,769	12,121	20,251

Table IV.—CONSUMPTION OF COAL ("Electrical World", 27.1.58/105)

Year	Million tons	Lb/kW-hr
1941	62.67	1.34
1942	66.26	1.30
1943	77.30	1.30
1944	80.08	1.29
1945	74.72	1.30
1946	72.20	1.29
1947	89.53	1.31
1948	99.59	1.30
1949	83.96	1.24
1950	91.87	1.19
1951	105.77	1.14
1952	107.07	1.10
1953	115.90	1.06
1954	118.38	0.99
1955	143.76	0.95
1956	158.28	0.94
1957	162.04	0.93

thermal efficiency of an American power station in 1955 was 37·46%. This was obtained at Kyger Creek, Cheshire, of the Ohio Valley Electric Corporation. In this station there are installed five units of 217,260 kW, representing a total capacity of 1,086,300 kW. The operating conditions are 2,000 psig, 1050°F with reheating to 1050°F. The Clifty Creek station, near Madison, Indiana, designed for the same conditions and having same size of units, but six instead of five, and giving a total station rating of 1,303,560 kW, was second with a thermal efficiency of 37·34%. These two stations supply power to the largest diffusion plant in U.S.A. They were com-

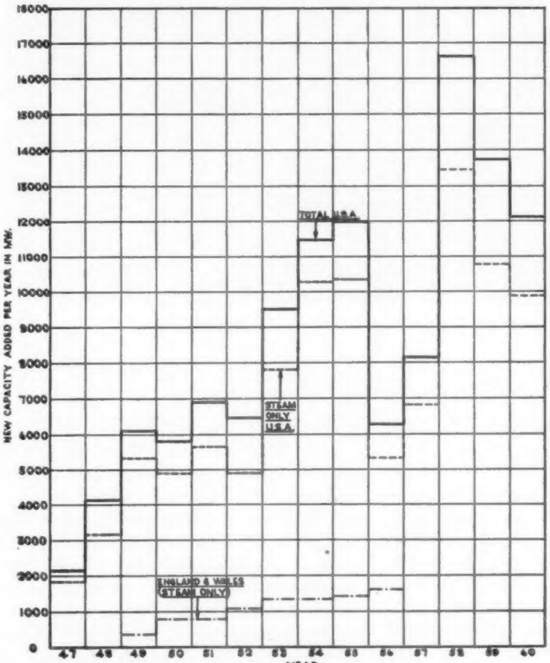


Fig. 4.—Annual increase in new additions to the capacity of steam plant and the total of hydro, steam and i.c. engines

missioned in 1955 and 1956, the eleven sets have a total capacity of 2,389,860 kW.

As far as Great Britain is concerned, the highest thermal efficiency in 1955 was 31·42%. This was obtained at Portobello power station which was designed for 1,350 psig and 950°F and non-reheating. Such conditions had been used in 1941 for Battersea B which held the record for the highest yearly thermal efficiency for six successive years, with 27·4% in 1941 to 26·49% in 1946.

Table V.—THE NET HEAT CONSUMPTION AND THE NET THERMAL EFFICIENCIES OF THE FIFTEEN MOST EFFICIENT STEAM PLANTS IN U.S.A. (BASED ON 1955 HEAT RATES REPORTED BY F.P.C.)

	B.Th.U/kW hr S.O.	Thermal Efficiency S.O. %
1. Kyger Creek (Ohio Valley Electric Corp.)	9,110	37.46
2. Clifty Creek (Indiana-Kentucky Electric Corp.	9,143	37.34
3. Kanawha River (Appalachian Electric Power)	9,151	37.30
4. St. Clair (Detroit Edison Co.)	9,220	37.01
5. Muskingum River (Ohio Power Co.)	9,234	36.96
6. Tanners Creek (Indiana & Michigan Electric)	9,273	36.81
7. East Lake (Cleveland Electric Illuminating Co.	9,336	36.56
8. Philip Sporn (Ohio Power Co.)	9,341	36.55
9. Shawville (Pennsylvania Electric Co.)	9,368	36.42
10. Albany (Niagara Mohawk Power Co.)	9,373	36.41
11. El Segundo (Southern California Edison Co.)	9,417	36.24
12. Oak Creek (Wisconsin Electric Power Co.)	9,480	35.91
13. Kearney "B" (Public Service Electric & Gas Co.)	9,511	35.88
14. Dunkirk (Niagara Mohawk Power Corp.)	9,523	35.84
15. Cromby (Philadelphia Electric)	9,540	35.78

For the year ending December 31, 1957, Castle Donington, operating at 1,500 psig and 1,050°F at the turbine stop valve and non-reheating, held the record for two years in succession with an average efficiency per unit sent out of 31·92% which is 1·237% above the previous year of 31·52%.

Drakelow-A having the same initial condition but a lower vacuum is second on the list with 31·02%, i.e. 2·88% less. Meaford-B also with the same steam conditions as Drakelow is only 29·83% and is 8th on the list of twenty of the best stations in England and Wales for 1957. Only five stations have a thermal efficiency above 30%.

In America, far greater advances have been made in the development and operation of reheating plant for at least a total of 30 million kW have been installed, i.e. about 50% more than the grand total generating capacity in Great Britain. However, the first 2,350 psig, 1050°F/1050°F turbines are to be started up in 1959-60 at High

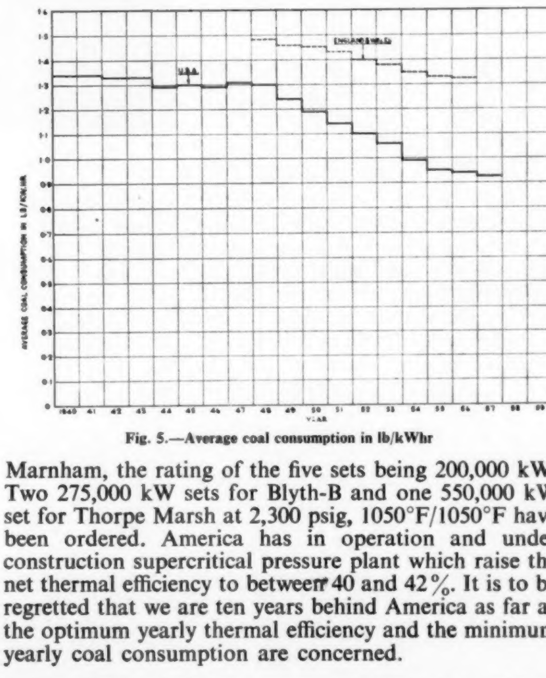


Fig. 5.—Average coal consumption in lb/kWhr

Marnham, the rating of the five sets being 200,000 kW. Two 275,000 kW sets for Blyth-B and one 550,000 kW set for Thorpe Marsh at 2,300 psig, 1050°F/1050°F have been ordered. America has in operation and under construction supercritical pressure plant which raise the net thermal efficiency to between 40 and 42%. It is to be regretted that we are ten years behind America as far as the optimum yearly thermal efficiency and the minimum yearly coal consumption are concerned.

8. The predicted electric energy requirements in U.S.A. for 1965 and 1975

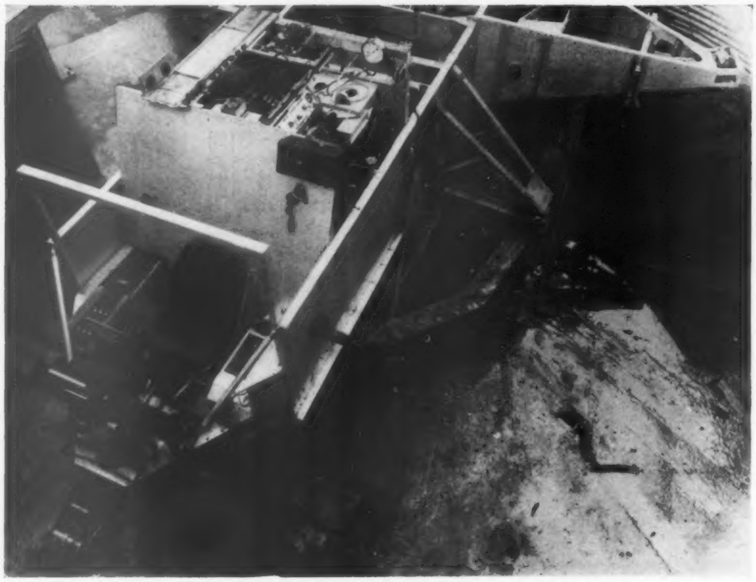
These are indicated in Table VI which also gives the energy produced by water, coal, oil, gas and nuclear power as a percentage of the total. In 1965 coal will generate 61·52% and nuclear power only 1·2%. In 1975 the corresponding values are 67·16% and 3·42% respectively.

Table VI.—PREDICTED ELECTRIC ENERGY REQUIREMENTS IN U.S.A. FOR 1965 AND 1975 (in 1000 Million kW hr)

	1965		1975	
	1,000 Mill kW hrs	%	1,000 Mill kW hrs	%
Hydro	184	15.66	266	11.09
Coal	723	61.52	1612	67.16
Oil	66	5.62	139	5.79
Gas	188	16.00	301	12.54
Nuclear	14	1.20	82	3.42
Total	1175	100.00	2400	100.00

Skeleton Aircraft for VTOL Development

Dynamic simulator rig for SC.1 research programme



Cockpit of simulator and view above equipment compartment

A "SKELETON" aircraft which will never leave the ground has been designed and built by Short Brothers & Harland Limited, to provide an advanced type of simulator for use in the development of the SC.1 VTOL research aircraft. The simulator, which takes the form of a dynamic rig, will serve a dual purpose. Not only will it enable the Company's pilots to become familiar with the control characteristics of the aircraft, but it will also be used for the actual functional testing of the hydraulic, auto stabiliser, elevator power control and air nozzle systems of the SC.1—thus eliminating the need for a separate test rig for each system.

The dynamic simulator rig consists basically of a skeleton framework, representing the SC.1's fuselage and mainplane, in which the appropriate components are mounted, and the entire structure is supported by a specially designed spherical air bearing which permits the rig to move freely on a cushion of compressed air with virtually no friction. Hydraulic and electrical services, auto-stabiliser and transistor mechanisms, as well as all instrumentation necessary for pilot familiarisation, are duplicates of those used in the actual aircraft. Recording instruments for functional testing are installed in a separate room and connected to the rig by overhead cables. At a later date it will be possible to operate the rig remotely from this control room, either manually or by signals fed from a Short analogue computor.

The advanced type of simulator built by Shorts for use in development of the SC.1 VTOL research aircraft. The simulator enables the company's pilots to become familiar with the control characteristics of the SC.1. It is also used for functional testing of the SC.1's hydraulic auto-stabiliser, air-nozzle, and other systems, thus eliminating the need for separate rigs

Although no engines are mounted on the rig, ducting and air jet control systems are the same as in the SC.1, the necessary compressed air being supplied by either a modified Rolls Royce Avon or Nene jet engine housed in an adjacent building. The air is ducted from the engine room, through a central hole in the spherical air bearing to a distributor head on the rig. To avoid adverse ground effects, however, the control nozzles in the wingtips, tail and nose—which, in the aircraft, provide lateral and longitudinal stability by their downward efflux—are inverted on the simulator to exhaust upwards; compensation being made by incorporating reversing links in the control circuits and correcting the auto-stabiliser accordingly. Aileron and elevator control surfaces are simulated by torsion bars and masses, representing respectively load and inertia. The rudder is not represented.

The programme being carried out on the dyanamic rig will also include special emergency tests, in one of which the results of a failure in one of the aircraft's four vertical lift engines will be simulated. This will be achieved by moving a mass on the simulator to give an out-of-balance moment equal to the displacement of the vertical jet thrust centre, and at the same time shutting one of the ports in the air distributor head.

Using the Basic Elements of Management Accounting

Relating the cost and elaboration of an accounting system to the size of the business apparently puts the smaller concern at a disadvantage. This need not be if actual needs are treated from the fundamental basis of management accounting. The manager or engineer is thus enabled to make decisions based upon facts

By GEOFFREY BAMFORD, A.C.C.S.

MANY small firms have a good case for complaining that for them a complete system of standard costing and budgetary control, although interesting and even fascinating in itself, is too elaborate and expensive to be economical in their particular organization. But let us not because of this fall into the trap of assuming that this means that the company is automatically denied the advantages of greater efficiency and productivity which accrue from the use of what we call Management Accounting.

Management accounting is a name which describes accurately the function to which it applies: it is the accounting for labour, material and overheads in such a way that its presentation to a manager or engineer enables him to make decisions based upon facts. It is of how much of this information we can provide for management with the least expenditure of labour that I would like to draw attention to in this article.

Firstly, then, let us consider the three things which the company must be doing at the moment and which require only manipulation in order to provide us with a mine of information for management. The company must at present be:

(1) paying wages
(2) issuing materials
(3) paying for overheads

Dealing first with the payment of wages, it is well known that it is necessary for management to know on what particular operation or job the workman has spent his time and it is not necessary here to go into the many ways in which this information can be obtained; what can be said with some emphasis is that complete analysis of every slight deviation in the daily work of employees is not necessary. Far too much time and money are wasted in many concerns on analysing labour to a ridiculous degree; it is not, for example, of interest to management to know the separate costs of sweeping floors, cleaning windows, brewing tea or erecting Christmas decorations—the whole lot represents a loss of productive time. On the other hand, the cost of training employees in a department is required as it has a very important effect on the productivity of the department, not only at present but also in the future. The conclusion, then, is that management must decide the degree of analysis of labour and demand full analysis of those elements which are of positive value.

The issue of material and its correct allocation to the job or department to which it has been issued has always and probably will always be a problem to the small firm. For the benefit of the management and staff, and still bearing in mind the fact that we are dealing with a small firm requiring economy in staff, I would suggest that on the material side of the business it is easy and profitable to make use of standard prices for receipts and issues, a price variance being thrown out each month.

The advantages of this method are easy to see in that the issue of items in constant use can be done on a pre-calculated issue voucher which can be duplicated and so make a tremendous saving in the pricing and extension of requisitions. The setting of the standards should not prove to be a very difficult operation, one person at least in every company is sufficiently conversant with material prices to be able to fix a reasonable standard. One point that must be stressed is that the tendency to adjust prices frequently must be resisted or the main advantages of the system will be undone.

The last of our elements of cost is that of overheads, here I would advocate the use of a budget. It is not a difficult or lengthy process for a company to estimate its expenditure for a period of, say, the next twelve months. The amount of detailed analysis required is once again the guiding factor: if management insists that wherever possible like items of expenditure be grouped and analysis demanded of only the most essential items, then an enormous saving in labour can be effected; for example, printing, stationery, telephone and postage, can very easily be considered under the one heading of office charges, thus saving time and labour in useless analysis. If it is proved at some future date that the item of expense known as office charges is increasing to some extent, then an analysis can be demanded immediately and positive action taken.

Having obtained its forecast of expenditure for the next twelve months, management has only to calculate the direct labour hours that it intends to work during that period in order by a simple division to provide a recovery of so much per direct labour hour.

Let us now recapitulate and see what we have achieved with the expenditure of a very slight amount of clerical labour. We have:—

(1) Labour analysed to direct and indirect work to the extent that management considers necessary.
(2) We have receipt and issue of material at standard prices with a total amount of variance being thrown out each month.
(3) Overhead recovery is being calculated at a predetermined rate per direct labour hour: this will result in a variance being thrown out at the end of the year.

We have thus laid down the foundation upon which the most elaborate of accounting systems is based. We have information which can at the request of management be analysed to throw light on particular developments. All this will, of course, cost clerical labour but if the analysis is done with a particular purpose in mind at the request of management and on which information

management can take positive action, then the expenditure is justified. The basis which we have provided can be developed as the company develops, analysis of the monthly variance figure of material price is an obvious first step, the breakdown of the overhead figures to give a monthly variance the next, and further analysis of this figure in order to give a variance on each particular item of expenditure, so that management can be informed each month of deviations from the budgeted figures. In short, management accounting is within our grasp.

Epicyclic Gear Tooth Loading Equilibrated by Nylon Keying

The most revolutionary feature of the Andantex epicyclic reduction pulley unit is the unique use of nylon to key the planet pinions to their respective shafts. This method overcomes the difficulties experienced in equilizing gear tooth loading when more than one multiple gear train is fitted round the central sun gears. Using the conventional method of steel keys and key-ways one set of planet pinions can be easily fitted, but the assembly of the second set requires very accurate setting of the key-way position, and more particularly as all the pinions used are of the single helical type made from nickel-chrome steel, hardened and ground.

In the patented method used for the Andantex pulley the reduction unit is permanently assembled. The pinions are mounted on their shafts and left free to rotate so that they can take up their natural position. Special adaptors are used in the position of the planet shaft bearings thus enabling the planet gears to be pre-loaded and set in their correct position in relation to the central sun gears. This assembly now forms a mould which is pre-heated and liquid nylon is injected by a specially designed nylon injection press. The adaptors are then removed and the correct ball and roller bearings inserted. Slight elasticity in the nylon allows the bearings to give the pinions sufficient working clearance and thus equilibrates the load upon them.

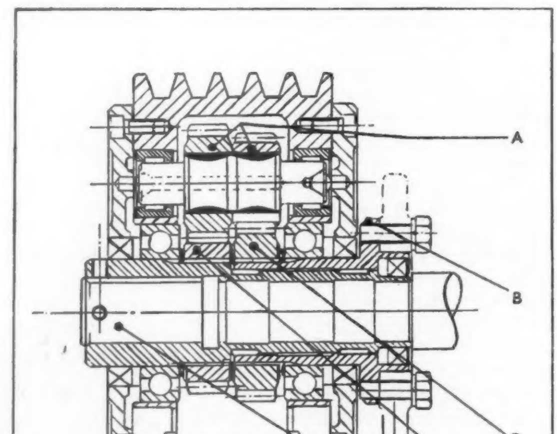
Immobilization of one of the sun gears is by the use of a standard torque arm fitted with leaf springs and

restrained by a stop, or as an alternative several specially designed torque limiters or clutches mounted on the side of the unit can be used to obtain two separate speeds.

Another important feature of the nylon keys employed in the unit is the positive safeguard they provide against damage through overload or careless operation. Under conditions of overload when fitted with the standard torque arm, the springs will break or twist at three times more than the normal pulley load. With a mechanical torque limiter fitted the load is pre-set and if overloading should occur power is automatically cut or the drive disengaged. If, for any reason, the particular safety device should fail, then the nylon injected keys within the pulley itself will shear without causing damage at four or five times the normal load. Should the nylon keys shear as a result of such an overload the repair of the unit is a simple matter of reinjection of nylon which can be effected by the makers within a few hours.

Andantex reduction pulleys are made in 16 sizes to transmit up to 80 hp. The range of speed reduction obtainable is very varied, 21 set ratios being available ranging from 2·79:1 to 273:1 in cases where the driven shaft rotates in the same direction as the driving shaft, and when the driven shaft rotates in the reverse direction the range is from 1·79:1 to 272:1. The units are completely self-contained, the case being used as an oil bath and the whole sealed by high duty oil seals.

The sole licensee for the manufacture and sale in the United Kingdom and Commonwealth countries is Furnival & Co. Limited, Reddish, Stockport, Cheshire.



Section showing the construction of the Andantex reduction pulley. A, planet gears keyed by nylon to their shafts. B, locking disc. C, input sun gear keyed to locking disc. D, output sun gear keyed to hub. E, driven shaft. F, fixed torque arm with leaf springs Left, cut away view of the pulley

Braking Methods with Induction Motors

Illustrating purely electrical methods of bringing a.c. motors to rest by rapid deceleration, created by a retarding electrical field in the winding

IN many classes of electrically driven machinery the provision of some means of braking is essential. It may be for use in emergency; where rapid deceleration is required in connection with the operating cycle of the driven machinery; or to prevent the motor speed rising unduly when driven by the load as might occur with such drives as lifts and hoists. Apart from a solenoid operated mechanical brake, there are several purely electrical methods applicable to a.c. induction motors, the two most common being known as (1) plugging or counter-current, and (2) dynamic or injection braking.

Plugging

With this system, braking is effected by reversing the direction of rotation of the stator field relative to the rotor. Reversal of the stator field is accomplished by interchanging any two of the three supply lines connected to the stator, and this necessitates an additional double-pole or triple-pole contactor in the stator circuit. Fig. 1 illustrates the main circuit in connection with this type of braking system.

The auxiliary circuits controlling the "running" and "plugging" contactor coils are electrically interlocked so that the plugging contactor closes immediately after the running contactor has opened for any reason. Reversed current is then applied to the motor winding and maintained continuously until the motor has come to rest, when the tripping relay comes into operation to de-energize the plugging contactor and permanently disconnect the supply from the windings. Alternatively, the plugging contactor may be controlled by a mechanically operated switch, so arranged that after the motor has come to rest, a small movement in the reverse direction opens the switch contacts, thereby de-energizing the plugging contactor and stopping the motor.

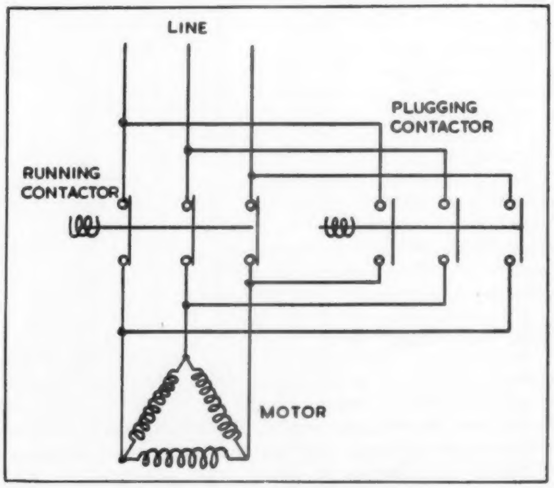


Fig. 1.—Main circuit for plugging control

This system can be applied also to slipring motors, and where such motors operate under normal running conditions with the external rotor resistance short-circuited, means must be adopted to re-insert the resistance in circuit before braking is initiated.

The disadvantage of this method is the high energy loss dissipated in the rotor circuit during braking, and from synchronous speed to standstill the total loss dissipated is three times the kinetic energy at maximum speed.

D.C. injection braking

In this method, braking is effected by disconnecting the motor from the a.c. supply system by opening the normal circuit-breaker, and then connecting a source of direct current to two or three phases of the stator. The d.c. excitation on the stator produces a stationary field system whereby the motor operates as an alternator driven by the stored energy of the coupled load. Braking torque is then developed by the resulting currents produced in the rotor circuits. A considerable measure of control can be obtained by the variation of the d.c. excitation, and in the case of slipring motors, by means of the normal starting and accelerating rotor rheostat. The d.c. supply for the excitation of the stator may be obtained either from a rectifier or a separate motor-driven generator, but a metal rectifier is the better alternative, as standby losses and maintenance are negligible. Furthermore, rectifiers can be arranged for any desired values of excitation voltage and current without the difficulties which this presents in the case of a generator supply. Star connected stators are more suitable for excitation purposes than delta connected stators, as the latter type of connection results in the excitation of all three stator phases, which requires a higher excitation current at a proportionally lower

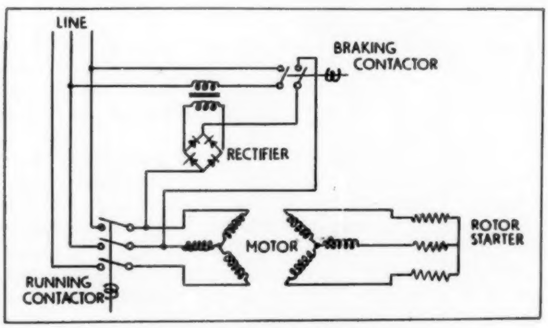


Fig. 2.—d.c. injection braking system

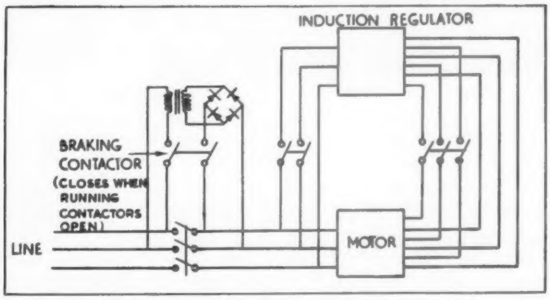


Fig. 3.—Injection braking system for a.c. commutator motor

voltage than the star connection in which two phases only need be excited.

Fig. 2 shows a typical example of a d.c. injection braking circuit.

The motor starts in the normal manner by operation of the stator and rotor starter contactors. When the "stop" button is pressed to disconnect the "running" contactors from the line, the electrically interlocked braking contactor is automatically energized, thereby energizing the rectifier transformer and simultaneously connecting the rectifier to the motor stator with the consequent excitation of this winding. The braking period is usually controlled by a timing relay, and at the end of this period the braking contactor opens automatically to disconnect the rectifier.

The main advantage of this method of braking is the relatively low energy loss dissipated in the rotor circuit during braking, being only one-third of the value produced by the "plugging" method. The motor cannot run backward as could occur with reverse plugging. The time required to brake the motor is easily adjustable by variation of the injected current, and if this is supplied from a separate source, braking will not be affected by a mains supply failure.

The system of injection braking is particularly suitable for a.c. commutator motors. The circuit is illustrated in Fig. 3 and with this type of motor the braking torque, rising with decreasing speed, results in more effective braking than with induction motors. Only two of the three rotor phases are left in circuit, the third phase being open-circuited. In the two phases remaining operative resistors of suitable ohmic value are inserted.

Timber Research

Work at the Forest Products Research Laboratory touches upon a number of factors of constructional interest. A possible cause of rot in the timber of water-cooling towers has been detected

THE transfer of responsibility for some of the Forest Products Research Laboratory's work to the Timber Development Association early this year changes the pattern of research which has been carried out at Princes Risborough since 1927.

Over most of its life it has been the only organization conducting research centrally for the timber-using industries—but since the Timber Development Association set up its own laboratories it has accepted an invitation by the Research Council of D.S.I.R. to undertake some of this work, including strength properties of timber, kiln drying and the utilization of wood waste.

According to the annual report* of the Forest Products Research Board, this means that F.P.R.L. can devote more time to research that could lay the foundation for new developments. These might include an investigation into home-grown timbers, with special emphasis on their pulping properties. The yield of these timbers is increasing annually and the economic disposal of surpluses (over pit wood requirements) is clearly a problem of national importance.

The Board's proposals for the next five-year period from 1959-64 have been put before the Research Council for consideration.

The Report of the Director contains a summary of work carried out last year. It includes:

Seasoning

A timber-drying kiln with an air circulatory system of novel design has been installed. Six-foot diameter fans are suspended horizontally between the false ceiling and the roof, and curved metal deflectors cause the air to flow laterally through the timber stack to one side or the other according to the direction of rotation of the fans. With this arrangement, less headroom is required than with a cross-shaft kiln with large fans of more orthodox design, and since the fans are driven on shafts through the roof, there is no need for space to be left at the sides of the kiln for the motors or drives.

Work on the effect of air speed on drying rate has shown that a speed of 4 ft/sec would be adequate for drying an 8-ft wide pile of green timber such as 1-in. beech when the direction of air circulation is reversed at fairly frequent intervals. With 1-in. Scots pine there were indications that the optimum speed would be little in excess of 5 ft/sec.

Hand saws

Information obtained from a study of the speed and direction of motion given to hand saws in normal use has enabled a machine to be designed capable of eliminating the vagaries of hand operation. With this machine a detailed investigation of the factors affecting the performance of hand saws is being made.

Soft rot investigations

In studies of cellulose-destroying micro-fungi which cause soft rot in coniferous woods, it has not hitherto been possible to bring about rapid decay by these organisms under laboratory conditions. Good growth of *Chaetomium globosum* and marked decay were, however, obtained in samples of Scots pine sapwood by first treating the samples with chlorine water before exposing

* Forest Products Research 1957, published for D.S.I.R. by H.M.S.O. price 6s. 0d. (1 dollar 8 cents U.S.A.), 6s. 5d. by post.

them to the fungus. The possibility arises that chlorination may accelerate the rotting of timber in water-cooling towers and further work on this subject is planned.

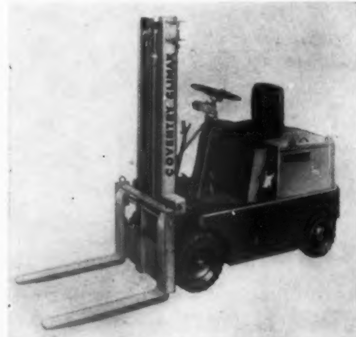
Distortion in plywood

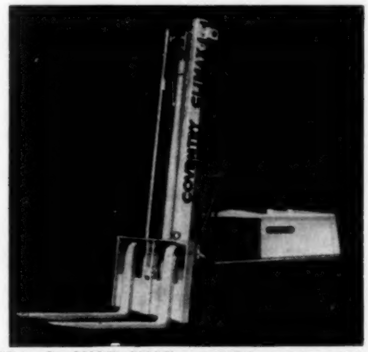
A study of the behaviour of the veneer during the glue-spreading and pressing processes has shown that the main cause of distortion in plywood of balanced construction is variation in the stress developed in the veneers during the pressing process. It was also shown that this variation would be minimized if the veneers could be spread and immediately pressed at a temperature of about 75° C (167° F).

Introducing Standardization for Electric and Petrol/Diesel Fork Lift Truck Range

Maximum interchangeability of parts is an important feature of the Coventry Climax Universal series of fork lift trucks, a new range covering diesel, petrol, L.P.G. and electric types from 2000 to 4000 lb capacity built by Coventry Climax Engines Limited, Coventry.

The standardized and interchangeable components common to all models include the drive and steering axles, mast assembly and hydraulic equipment. Other features common to the series are a longer wheelbase and improved weight distribution within a shorter overall length, reduction of the axle centre/fork heel distance so as to improve the lifting capacity and a lower centre of gravity.





Left, one of the Coventry Climax Universal electric fork lift trucks, 2000 lb, 3000 lb and 4000 lb capacity models are available. Right, the Coventry Climax Universal fork lift truck, cushion tyred diesel petrol/L.P.G. models of 4000 lb capacity

In order to keep the battery low on the electric models, it was necessary to adopt the four wheel layout for the Universal range, in preference to the "three point" wheel layout which has proved so successful on other Coventry Climax models, and care has been taken to balance out the wheel loadings, so that adequate adhesion is available when the truck travels light.

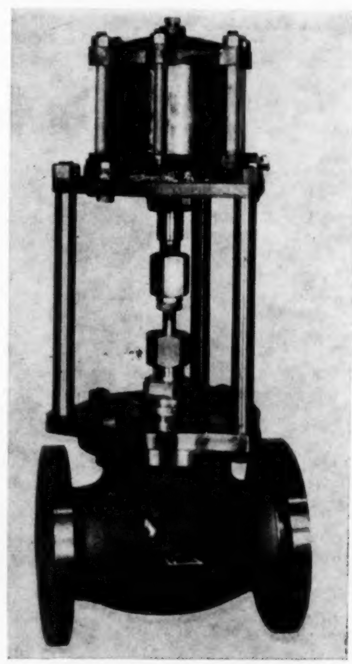
Pumping Heavy Greases

The problem of handling heavy greases has been tackled by C. C. Wakefield & Company Limited who have introduced a range of floating grease pumps.

These new pumps are easily attached to grease packages and literally "float" upon the grease. In operation they "suck" their way downwards with a complete absence of channelling and cavitation. A thorough evacuation of the container is obtained with no risk of contamination and the messy, time-consuming job of transferring heavy greases by hand is eliminated.

Two models are available, marketed by Wakefield-Dick Industrial Oils Limited and both operate on an air pressure of 80 or 150 psi. The low pressure model delivers grease at 400 psi and the high pressure model gives a delivery of 6000 psi.

Floating grease pumps made by C. C. Wakefield & Company Limited, Grosvenor Street, London W1



AIR CYLINDER OPERATED VALVES.—For working pressures, saturated steam up to 300 psi; superheated steam up to 250 psi and 500° F; and oil and water up to 500 psi at 150° F, these valves are available in sizes 1 to 4 in. with flanged connections to B.S.T. 'E', 'F' or 'H'. The valve body is manufactured from a bronze casting with bolted cover, renewable nickloy valve discs and seats, and stainless steel spindle. The cylinder is secured to the cover of the valve by heavy mild steel pillars. The cylinders are suitable for operating air at 60/110 psi and may be single acting with spring return or double acting. The valves are manufactured by Hunt & Mitton Limited, Oozells Street North, Birmingham 1, in two types either air to open or air to close

Bulkhead in high tensile aluminium alloy machined from the solid billet. Original billet weighed 23 cwt. Finished components 8·3/4 cwt

Battery of Wadkin routing machines engaged on aircraft component production

Precision Metal Routing

Very high speed machining so reduces labour cost as to overcome the effect of removing a great bulk of metal. Current development includes work on titanium for aircraft and nuclear power plant

THE high-speed milling process known as metal routing derives from the machine woodworking process of the same name. It is much used for the shaping of intricate forms in light metal components, work for which it is admirably suited both technically and economically. Messrs. Morfax Limited, of Mitcham, who have been responsible for much of the development of the process, have recently established a subsidiary, Routing Limited, with a factory at Foggs Road, Feltham, to specialise in routing—probably the only concern engaged exclusively in this process.

Routing is faster in operation than the band-saw, and imparts less stress in the material and has the further advantage that sheet materials can be profiled to template. Fundamentally the routing machine consists of a platen or work bench, and a motor-driven spindle carrying a cutting tool. The arm supporting the driving head and cutter can be moved over the whole area of the work piece. Material is removed by the action of the cutter rotating at high speed and biting into the surface or edge of the material according to the type of cutter used.

A template or guide arrangement is fitted over the work piece in such a manner, that a loose collar or roller mounted on the driving spindle can be maintained in contact with the edge of the template by pressure applied to the head by the operator. Spindle speeds vary from 3,000-24,000 rpm according to the material being cut and the diameter and setting of the cutting tool.

In 1939, experiments were made to develop the process for machining light alloys particularly in connection with aircraft components. The advent of the war lent impetus to the expansion of the process and it was extensively used as a roughing or rough-forming operation on light alloy components. At that time, the speed with which non-ferrous metals could be removed by the routing cutter excited the interest of production engineers. Unfortunately, the process was deficient both in regard to accuracy and depth of cut obtainable. For some time, therefore, it had a limited use as a roughing-out tool for light alloy sheet material.

With the development of high-speed flight, designers were faced with the production of lighter structures which had to be capable of withstanding increased stresses. Attention was turned towards the high-tensile light alloys and the adoption of monocoque construction in airframe design. This break away from orthodox composite fabrication called for an economical method of rapidly machining to fine limits the intricate sections and components from the solid billet.

The routing of components from the solid billet involves the removal of a lot of material, but apart from

physical considerations the cost of material compared with that of the labour involved renders the process an economic one, for although the material is expensive, the speed of the process reduces the cost of labour and therefore the overall cost of manufacture.

As sub-contractors to many leading aircraft firms, Morfax Limited received requests for the economic production of experimental machined components from the solid, in the new alloys. In 1953 they decided to investigate the possibility of improving the routing process and an experimental routing shop was set up at their Mitcham Works.

At about this time Vickers Armstrongs (Aircraft) Limited, at South Marston, had succeeded in rough routing spars from the solid billet. The deeper cuts were obtained by successive passes of the cutter and the final machining was made on expensive copy milling machines (Hydrotels). These machines, which had to be imported, whilst giving the necessary accuracy were slow in operation and therefore uneconomical in production. It was largely due to these circumstances that interest was centred round the improvement of the routing process.

Method of producing a helical form on routing machine. The component is an aircraft half-frame in aluminium alloy. The template is made from mild steel and carries the true helical form. The template follower is radiused and holds the radiused cutter in the correct position for each of the cuts which are made in a series of passes along the length of the job. Starting at the top each successive pass is made in steps of 0·010 in. progressively downwards

Component in S.99 alloy steel being machined by routing utilising CO_2 coolant. Template is located over the work piece. The centre aperture allows pocket to be machined in register with the profile

For their part, Morfax Limited set about increasing the depth of cut that could be made in one pass of the cutter and they produced a cutter which successfully cut a depth of 3 in. in light alloy material. In the course of these early experiments, close liaison was established with the manufacturers of the routing machines, Wadkin Limited, of Leicester, and this co-operation eventually led to the development of equipment capable of cutting to a depth of 6 in. or more. The Morfax experimental team produced special cutters for this work and Wadkins stepped up the power of the driving head in order to accommodate the new cutters.

Efforts were next turned towards improving accuracy, this was achieved by a combination of cutter-guide and template modification together with further studies of cutter tool design. Success in this field eventually led to the production of form tools and the variety and scope of the improved process enabled the routing department to undertake production runs in addition to the prototype work. With the increased loads involved on the routing machines, Wadkins Limited produced new equipment of more robust and versatile design which enhanced the accuracy and efficiency.

Another application of the process has been the development of skin-milling for aircraft and similar highly stressed sheet components. In this operation, the thickness of the sheet or skin is reduced over all areas except where stiffeners, ribs or attachment points are located.

The result is a skin possessing integral stiffeners and reinforcement machined from the solid and having all changes of section evenly radiused.

Examples which may be quoted are sheets measuring 12 ft × 4 ft which have been routed from their original thickness of just over ¼ in. to 0·080 in. over the thinnest areas. Other skins have been reduced from the same

Finishing a skin-milled aircraft panel by the Vacublast process. This machine impinges an abrasive powder on the surface of the material and collects the discharged powder by vacuum. The blasting and vacuum nozzles are concentric. The apparatus filters the powder for re-use

thickness to 0·023 in. which demonstrates the degree of control now possible.

Routing machines have now been produced in a variety of types and models. Hydraulic depth control is available on some of the latest, together with features which facilitate accurate and consistent work. Considerable experience has been gained in respect of tool design and manufacture and Morfax Limited have developed a department for producing special cutters, work fixtures and attendant equipment. The experimental department for Routing Limited has been retained at the Morfax Mitcham Works where, at the present time, experimental work is in progress in connection with the routing of titanium and high tensile steel alloys, work which has relation to nuclear power development as well as aircraft.

The new Routing factory is at present equipped with some twenty Wadkin machines of various types including three fitted with 20 hp heads and one with hydraulic depth control, and some nine more machines due for delivery within the next two months. In addition, there are special-purpose routing machines including a twin-operator skin milling machine capable of handling plates 6 ft in width to an unlimited length.

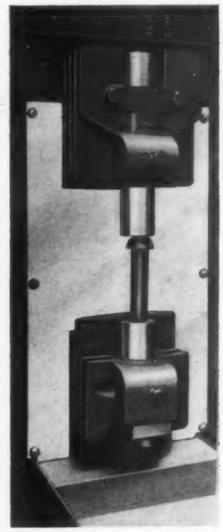
Supporting this installation are machines to handle tooling and templates manufactured for the Routing production line, including Victoria and Wadkin mills; Smart & Brown and Colchester lathes; Jones and Shipman tool and cutter grinders; a Bohner & Koehle boring machine with Hilger & Watts optical setting; and a V-36 Do-all bandsaw and filing machine. Blending and finishing equipment includes rumbling plants of various sizes and a Vacublast installation, the whole organisation being adequately covered by a well-set-up inspection department.

A new factory building of some 18,000 sq ft is being completed at the rear of the existing premises.

Instantaneous Rivet Heating Machines

All methods of rivet heating, other than the electric resistance method, waste a considerable amount of heat and a "warming up" period is required before they can be used. In addition, fuel is consumed whether the rivets are actually being heated or not.

With the latest range of Metrovick electric resistance heaters the first rivet is ready within seconds of the machine being switched on, thus saving in fuel costs and reduction in waiting time are appreciable, especially where the demand for heated rivets is somewhat irregular. Furthermore, the rivets being visible while heating, there is less loss due to overheating and burning, and the heat is concentrated in the shank, the head of the rivet remaining comparatively cool.



Left, Metrovick multi-head electric resistance heater. These machines may be built up with heads rated as follows: 10, 17, and 25 kVA; having maximum inputs of 15, 25 and 35 kVA. The respective normal heating range for M.S. rivets is $\frac{5}{16}$ in. × 1 in. to $\frac{7}{8}$ in. × 4 in.; $\frac{3}{8}$ in. × $1\frac{1}{4}$ in. to $1\frac{1}{8}$ in. × 4 in. and $\frac{3}{4}$ in. × $1\frac{1}{2}$ in. to $1\frac{1}{4}$ in. × 6 in. average output in lb/hr being 40, 65 and 90. Right, close-up of rivet in position between electrodes

In the multi-head machines, separate transformers are used so that each may be set on a different tapping if more than one size of rivet is required simultaneously, and to prevent the loading of one head affecting the heating speeds on the others. A further advantage of this arrangement is that in the rare case of damage to a transformer, one can be removed for repair, and the other heads of the machine brought back into immediate production.

The transformers are enclosed in fabricated sheet steel cases, on the fronts of which are mounted the electrode holders. The upper electrode of each pair is fixed in an easily pre-set position, according to the average length of rivet being used. while the lower one is spring loaded enabling it to be drawn away by depression of a pedal for loading and unloading. In order that the machines may be used in semi-exposed positions, the standard range is of drip-proof construction, and lifting eyes are provided for convenience in moving them about the assembly shop. They are built by Metropolitan-Vickers Electrical Company Limited, Trafford Park, Manchester 17.

Air-operated Machine Vice

Primarily intended for repetition work and to replace cam-actuated vices this robust high speed air vice has a clamping force of up to 2200 lb. The $3\frac{1}{2}$ in. hardened steel jaws open to 3 in. and the sliding jaw may be rapidly adjusted to a suitable position by means of a large screw and nut. The vice made by Dyson & Nalson, Viaduct Street, Huddersfield is suitable for bench or machine use and operates at a maximum air line pressure of 150 psi. The price exclusive of foot control valve, air hoses and fittings is £23.10s.

Dyson & Nalson machine vice

Industrial Adhesives

The enormous development of genuinely and economically important industrial adhesives is one of the most interesting phenomena of the post-war world. These adhesives were first used between 1939 *and* 1945 *to hold parts of aircraft together during flight, and it was found that they united components as firmly as rivets, screws, bolts, welds and soldered joints. Some work they could do even better. In the following notes the advantages and types of industrial adhesives are discussed*

THE primary advantage of industrial adhesives is their economy. In the first place, they are in most instances less expensive than other materials designed to unite component parts. Secondly, they are economical in labour cost, because a smaller number of highly skilled workers are required in their use. The assemblies in which they are employed can be put together at a more rapid rate, which lowers the production cost per piece. High temperatures are rarely required, and finishing processes on completion of the assembly are fewer as compared to mechanical joining. Use of adhesives often allows of simplification of the design, a reduction in total weight, and consequent saving in packing and forwarding. In most cases, also, the eventual construction is more robust.

But even when the above advantages are taken into account, they do not comprise all the benefits to be obtained. For example, industrial adhesives often render the designer's work easier, because they enable stresses to be spread over the whole bonded joint area, instead of concentrating at the points where holes have been made for screws, bolts or rivets. The result is a reduction in fatigue and consequently a longer service life of the finished assembly. Also it becomes possible to employ lower cost, more readily procurable, and lighter materials for gauges without any loss of strength or rigidity.

It must also be noted that industrial adhesives can now be had which unite almost all types of plastics or metals to extremely thin metallic constructions, and this is specially advantageous in packaging and other work, since the employment of adhesion enables foils of thin type to be united without distortion. For example, aluminium foil can be joined to a man-made fibre using a coloured adhesive, so producing a striking, ripple-free metallic yarn. Polyethylene can be united to cellophane, so producing an attractive transparent food package.

Adhesives also give designers in many instances a higher ratio of strength to weight than they can obtain from other methods of joining. Smooth forms are obtained, with the removal of gaps and bulges, while there are no external projections, as with some mechanical fasteners. The final surface is, therefore, satisfactory without additional work in many instances. Sealing and bonding can be combined in a single operation, and there is no risk of galvanic corrosion as when dissimilar metals are welded or soldered together.

Adhesives also provide a measure of electrical insulation, damping of vibration, and freedom of corrosion, because of the fact that water is not trapped at the joint. Dissimilar materials are easily united, and assuming correct choice of materials, flexible joints can be made, capable of being united to other flexible materials or to rigid materials, as may be desired.

We may now consider some of the industrial applications of these adhesives. In the form of sandwich panels, they are being used for curtain walls of tall buildings, transit cases, lorry bodies, and other applications in which a high ratio of strength in combination with light weight is an urgent requirement. In these panels, which did not reach their full development until the Second World War, rigid metal skins are united to light weight solid core material, or to aluminium, or to honeycomb cores of resin-impregnated paper.

The next important advance was the introduction of efficient adhesives of 'contact' type, which rendered possible the attainment of exceptionally high bond strength, high peel strength and flexibility, ease of handling and virtually instantaneous strength, without the need of special ovens for curing or for heated presses. Such adhesives have proved exceptionally useful for outside telephone booths, in which porcelain-enamelled skins are bonded to a core of fibreboard; as a joining medium for rigid plastic sheeting united to steel for household furniture; for aluminium and plastic facings over honeycomb core for office partitions; for plastic facings over rigid plastic cores for doors, etc., and for porcelainized steel over plywood and fibreglass for external curtain walls. All the adhesives used in these applications are inexpensive and solvent-dispersed.

The employment of these new contact adhesives involves a choice between two different processes. In the first, the adhesive is dried by air until fully dry to the touch, when it will refuse to stick to any surface other than one coated with the same type of adhesive. The material is applied to the two surfaces to be united, allowed to dry, after which the surfaces are placed in position and joined by pressure of hand or roll, which suffices to produce a safe union.

An alternative process is quicker and makes use of conveyor production lines. The adhesive material is sprayed on the surfaces to be united and caused to pass under infra-red lamps, which drive off the solvent completely and at the same time raise the temperature of the adhesive until it becomes somewhat thermoplastic. Before the temperature has had time to fall, the two surfaces are placed in position and compressed by revolving rubber rolls. As soon as the assembly is cool, the panel can be put into use. It has been claimed that as compared to resin-latex bonding with chemical curing, five times as many assemblies can be obtained with only 20% of the space required.

The use of contact adhesives is only effective if the adhesive possesses a higher shear strength than the core and is strong and rigid enough not to creep under applied load. These adhesives need also to be durable, non-ageing, and resistant to elevated temperatures. They must in no way impair or injure the plastic core or the facing materials. Foamed polystyrene, for example, can be attacked or dissolved by many solvent-type adhesives.

Some adhesives need to be more thoroughly dried than others to prevent any possibility that the bond may be impaired by trapped solvent or water. There are others of heat-curing type that must not be employed if the curing temperature exceeds the limits of the plastic foam.

Examples of industrial adhesives include one with a base of reclaimed rubber, which is said to give an extremely strong bond, as it contains swiftly-drying solvents that do not cause cell collapse in the polystyrene foam, while it can be brushed, sprayed or trowelled on to the surfaces concerned, according to requirements. Another adhesive of viscous, quick-drying, quick-bonding type is of mastic base and is designed for overhead work. Shoring is thereby reduced, and the cost of the work lessened.

Sometimes it is possible to brush the adhesive over large flat areas, or to spread it over plastic blocks with a spreader jig and tray. In such instances an adhesive of medium viscosity is used. A considerably lower viscosity is demanded for spraying.

Plastic foams are being extensively bonded by the newer adhesives, which include many different resins and rubbers, as well as special combinations that have to be carefully mixed and in proper proportions. These adhesives unite every type of flexible foam, but they must above all things have quick loss of tackiness, as otherwise the adhesive would cause the internal portion of the seam to bond to itself upon contact. Having been once used, it would then be permanently moulded into the form on which it had been depressed.

One-part adhesives have enabled cemented seams to be put under pressure after the loss of tackiness period with the certainty that the bonded assembly would recover its original dimensions and reveal no depressions whatsoever when pressure was released. Adhesives have been introduced which will bond urethane foam to metal for sound-deadening in the housings of typewriters and computers, and to many other materials.

Rigid plastics as well as the flexible are being bonded by the new adhesives. Pressure-sensitive adhesives are used. Permanently tacky adhesives are used for many purposes. These enable a chemical union to be obtained. Thus, in laminating oily varnished cambric to oily saturated asbestos, only an adhesive that retained its stickiness would produce a firm bond. A new American adhesive is made up of a light weight, porous, transparent paper carrier, saturated and coated on each side with a clear, aggressive super-ageing pressure-sensitive adhesive. This can be used for bonding the completely inert plastics, such as the tetrafluorethylene series.

Pressure-sensitive adhesives must be applied to firm, clean and dry materials, and the firmer, cleaner and dryer the materials, the better will be the contact and therefore the union. The pressure should be as firm as is feasible, as this makes the bond stronger and enables the release paper to be more readily removed.

In making printed circuit boards, adhesives are specially important. Pre-cleaned, copper foil is coated with one of a number of adhesives designed for the purpose, such as are on the market. The adhesive is applied to the copper, and is given the most careful curing by the manufacturer. The user has only to apply the foil.

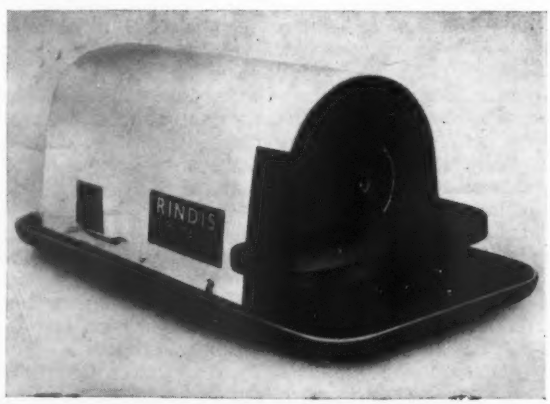
Typical modern adhesives include urea-formaldehyde, melamine-urea formaldehyde, phenol formaldehyde, resorcinol-formaldehyde, phenol-elastomer, epoxy, epoxy-phenolic, epoxy-polymide, epoxy-thiokol and neoprene-base thermoplastic families.

In choosing the proper adhesive for industrial use, the first thing is to decide what is required of it and how it should be applied. Brushing, spraying, roller distribution, flowing on, dusting on and laying on in film form for later heat or solvent reactivation are all possible. Exposure to heat, solvents, water, external weathering, special shear or peeling stresses, must all be taken into account. Economy may be a decisive factor in choosing the right adhesive.

The materials to be bonded are important according as they are affected by heat or solvents. No adhesive can be used for every job, but usually there are one or two obtainable for any specific purpose. It is always best to consult the adhesive manufacturer, and the user should indicate the materials he wishes to bond, sending samples, where feasible. He should indicate the service conditions as regards resistance to heat and the working temperature range; resistance to solvents, of what kind, and for what kind, and for what period; resistance to other chemicals, giving specific data, and for what period; resistance to sunlight; resistance to abrasion, of what type and for what periods; resistance to humidity, if required, of what degree and how often or for what periods.

He should then specify the range of bond strength required, and whether peel, tensile shear or impact strength is the more important. The degree of flexibility desired should be stated, and some indication given of the importance or otherwise of the colour of the dried adhesive film. Whether the adhesive must be non-flammable or non-toxic should be made clear, and the most satisfactory type of adhesive for the purpose in mind should be mentioned. For example, is the best form a powder, liquid, spreadable paste, mastic applicable by trowel, or film?

The user may have a preference among methods of application, and should say whether he wishes to brush, spray, dip, roller coat or knife coat the surfaces concerned. Viscosity required should be indicated, and the available drying time: whether heat curing is possible to him and for what period, at what temperature? He should say whether he can apply pressure, how much and for what period. Price restrictions should be stated and the kind of joining methods being used revealed, with indications why it is not suitable.



BENCH FILING MACHINE.—A new addition to the Rindis range of power disc filing machines has been introduced by Lorant & Company Limited, 98/100 Croydon Road, London SE20, to extend the existing series, The machine, the Rindis 10 in. bench model is suitably designed with precision cut gears and bearings for radial and thrust loads on the spindle. An inclinable work table which is adjustable towards the disc, has been provided to give alternative height positions necessary to accommodate work of varying thicknesses. The complete unit is mounted on a substantial tray and the cover acts as a guard to the disc and also houses a rotary switch. A wide variety of teeth arrangement is available and the machine can be supplied with any individual speed between 80 and 480 rpm to cover a wide range of materials from steel to aluminium

Colour Service for Industry

The facilities offered by a new laboratory

THE new Technical Service Laboratory building erected at Slough provides the Paints Division of I.C.I. with facilities for giving comprehensive technical service and for carrying out practical trials of new products and new techniques.

For the proper preparation of metal before the application of paint there is a well-equipped laboratory for the trial of new chemical-treatment processes and two tank-rooms for making practical trials of processes for the cleaning and derusting of metal.

Industrial finishing is catered for by a section which includes an application-shop, with separate rooms for flow-coating and electrostatic application, an oven-room with various stoving devices and a separate room for the training of customers' staff and other personnel, and separate rooms for wood finishing.

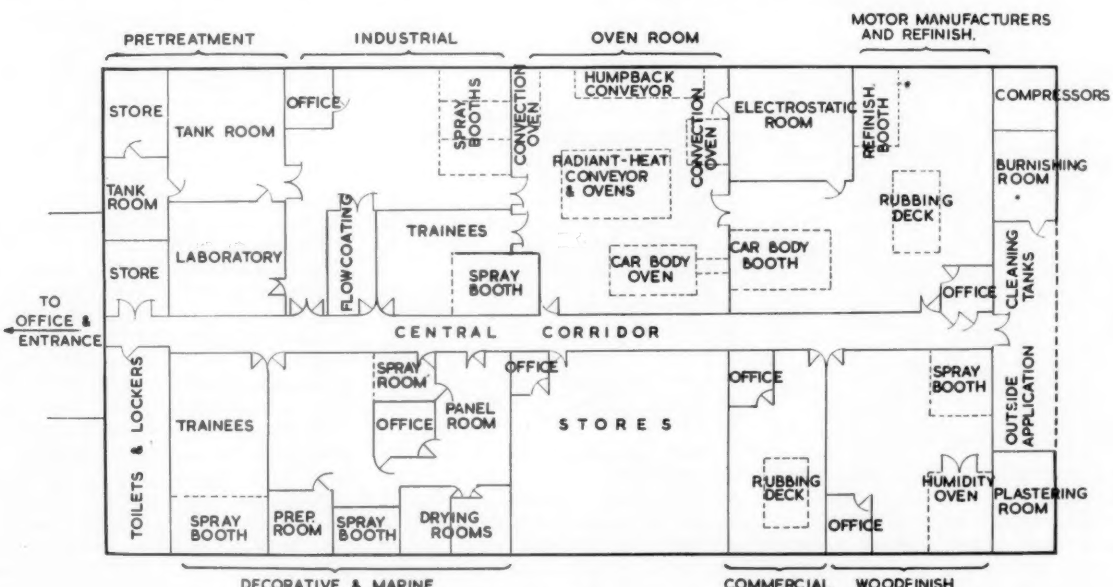
A transport section has facilities for finishing a number of motor-cars at one time, if necessary, although much work is carried out on sections of cars such as doors and wings. There is a totally-enclosed unit comprising a spray-booth and oven in which a large motor-car body can be sprayed under completely dust-free conditions and then passed along rails directly into the oven in which the finish is baked hard. There is also a rubbing-down area large enough to take a motor-car. Another room is for the trial of air-drying synthetic paints used on buses and coaches.

The new technical service laboratory of I.C.I. Paints Division is the most outstanding of its kind in the country, and possibly in the world. The service departments—pretreatment, industrial, motor manufacturers and refinish, commercial transport, woodfinish, decorative and marine—are housed in one building, together with oven room, trainee sections and lecture hall, equipped for the showing of training films

Probably the most important function of the decorative and marine section is the practical testing and assessment of building and marine paints from the viewpoint of the user. The section has its own room for the training of customers' personnel, complete with facilities for spray-application as well as brushing and roller-coating.

Colour advisory department

The colour advisory department has a largely independent function in the encouragement of good painting by choice of colour. It is equipped with studio, display room, projector and screen for showing colour illustrations and sample room.



Diagrammatic plan of the technical service laboratory

technique

devoted to the discussion of practical problems. Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance. Payment will be made for published contributions.

Any Questions? We welcome inquiries concerning difficulties arising out of our readers' general work, for treatment in the **technique** section. The full name and address of the writer (not necessarily for publication) must accompany each communication

Testing Helicopter Blades

A new rotor blade test tower has been designed and built by Bristol Aircraft Limited to speed the testing of production helicopter rotor blades. The tower—an octagonal steel and concrete truncated cone, 18 ft in height and with a diameter of 6 ft 6 in. at the top and 20 ft at the base—is one of the few towers to be built solely for production testing.

The tower represents the "hovering" condition and as the control systems of individual aircraft vary within small limits the final adjustments can only be made after flight testing. Nevertheless the value of pre-flight testing the aerodynamic profile, lift, out-of-balance and tracking characteristics is appreciable in that it enables a stock of fully tested blades and hubs to be maintained for spares and speeds the clearance of damaged blades returned for overhaul and repair.

Both wooden and metal blades are tested on the tower and although wooden blades have proved excellent in service the metal blades have certain advantages over the wooden blade namely—greater service life, better surface finish, easier production of a standard, easier repair and no change of characteristic with humidity. The changes which take place in a wooden blade with humidity make it extremely difficult to manufacture a standard blade and it is normal practice to make wooden rotors in sets of three or four blades in which it is not possible to change blades, in the matched sets, at random. The making of a master metal blade, however, is relatively simple and single blades, required as replacements, can be tested and adjusted against master blades without the necessity of testing a complete set.

Rotor thrust (lift), the power absorbed by the rotor, collective pitch (incidence angle of the blades), rotor rpm, blade pitching moment (rotor out-of-balance force) and tracking (blade position at tip-path-plain) are characteristics on which test results are recorded on control desks designed by Bristol Aircraft Limited and collated by operators who work in the control room built into the base of the tower. The Crompton Parkinson 400 bhp d.c. main motor and the blower motor starter are also housed in the base of the tower.

The drive to the rotor is from the main motor via a gearbox and a vertical drive shaft with a standard rotor hub at its upper end. A mixed Ward Leonard and shunt control system is used to control the speed of the motor over a range of 80-1264 rpm. The Ward Leonard control is used for the low speed requirement—80 to 800 rpm—because it is a convenient and economical way of obtaining slow speeds and a wide range of speeds, at constant torque. From 800 to 1264 rpm the full 400 bhp of the motor is available under shunt control.

The constant speed motor generator set, comprising an auto-synchronous motor and exciter and a generator and its exciter—all mounted on a common bedplate, runs at 1000 rpm. The motor generator set and its control gear, which includes an Allen West circuit breaker and liquid starter and a d.c. contactor panel which is controlled from the tower, are housed in a substation on a site adjacent to the tower. The auto-synchronous motor is supplied from 420 V, 3-phase, 50 c/s and is designed to operate at 0·95 leading power factor.

To facilitate work when changing the rotor blades, a working platform which may be raised or lowered electrically, is powered from a point external to the tower. Safety devices are incorporated in the driving motor circuits to ensure that the rotor blades cannot be set in motion when work is in progress on the blades.

Producing a Special Plug

The frequent removal of any threaded plug from a casting—oil drainage is a typical example where this operation is necessary—means that some other than the orthodox screwdriver slot is required to avoid the burring which soon results and renders the plug difficult to remove. Two designs are available—the hexagon headed plug familiar to motorists as the method employed for sump drainage, or the smaller hexagon of the socket screw which utilises a key as a tightening medium.

Both designs are unfortunately expensive to produce — expensive that is, in relation to their importance in a mechanism; thus such processes as milling or broaching hexagons are preferably eliminated.

With simplicity as the keynote the production of some 100,000 special plugs depicted in Fig. 1 would normally load a broaching machine for several weeks in an operation which, though possible at a single pass of the tool, is nevertheless more expensive than producing the piece in the previous workstage on an automatic.

The problem was overcome by introducing into the automatic cam cycle a process whereby the hexagon hole is produced while the piece is still attached to the bar, and the operation only extended the time by some three seconds.

Initially a hole of diameter equal to the distance across the flats of the hexagon was drilled deeply into the plug—a restriction of this depth is not advisable because swarf can tend to interfere with the drifting tool and a slight extra depth at this point is therefore useful. The normal quick turret approach is used until the drift is a matter of $\frac{1}{16}$ in. from the workpiece, whereupon it slows to a feed of 0·005 in. per revolution—a figure that ensures the drift biting into the bar: immediately the spindle into which the drift is fitted commences to rotate, and continues to do so during the broaching process. Further advancement of the turret slide causes the tool to drift the

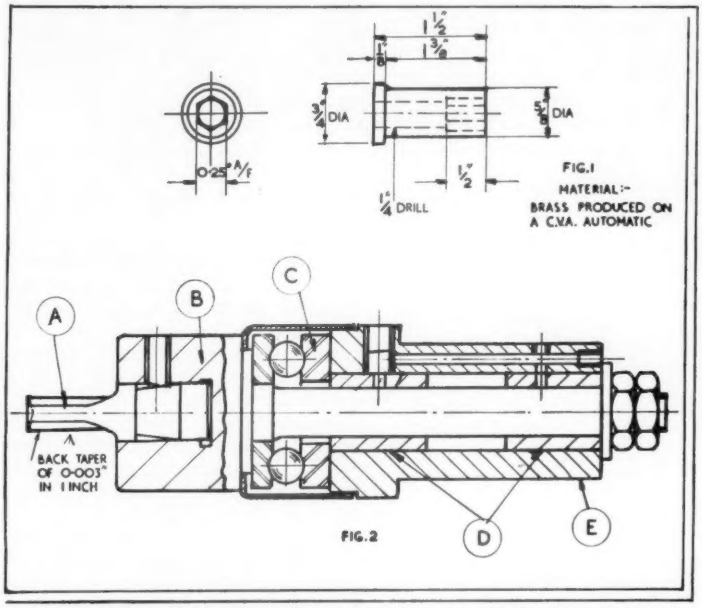


Fig. 1.—Simple plugs where the hole extends through the article or similar oil drain plugs with blind holes are typical automatic jobs where drifting is possible. In this example the hexagon hole only partially enters the plug. Fig. 2.—The drifting tool for use in an automatic cycle; drillings carry oil to the rear bearing when the holder is secured to the turret; A, tool. B, tool holder. C, thrust race. D, bearings. E, holder

unwanted material and for this a feed of approximately 0·002 in. per rev. is sufficient.

A difference between the distance across the corners and flats is the maximum amount of material this drift must remove—a simple trigonometrical calculation reveals this as 0·038 in. or 0·019 in. on each side of the hole, and with a comparatively short tool this is not difficult.

A back taper of 0·003 in. in one inch is essential to prevent any tendency of jamming—a contingency that would undoubtedly cause the tool to twist off—and a further angle is added to the front end to create a positive cutting angle.

Two phosphor bronze bearings gave a reasonable life before renewal became necessary, and adequate lubrication to these members was accomplished by drillings made in the holder. As the rear bush is impossible to oil separately, a long hole drilled horizontally to break into a cross hole into which an oil cup is inserted, is therefore required, and small plugs screwed into the drillings retain the oil.

A dozen tools were manufactured for this contract—the actual cost being greatly reduced by ordering this number and enough were available to allow replacement without delay to production. An important process is the tempering of the cutting end after hardening because if this end is too hard almost immediate fracturing results, but the soft brass material of the component means that a tool in a rather soft condition is preferable to one which is made extremely hard.

Automatics are notorious when operating on brass for swarf literally smothering all parts of the machine, thus a cover over the thrust race is essential and this must fit closely as particles suspended in the cutting oil can gain access to the race and clog that member.

Internal Grinding Spindle

Internal grinding is seldom attempted on any machine other than the orthodox version of machine tool yet there are occasions—notably in those small shops where articles of a general engineering nature and in numbers as low as a single item are manufactured, where an attachment would frequently assist in the production of parts especially when a close degree of accuracy is not easily achieved on a lathe.

For instance, the boring of holes and recesses to limits in the region of 0·0002 in. is work demanding considerable skill, and the finish obtained is again not always secured when the material is hard and tough and there are perhaps ports cut into the bore to create intermittent cutting.

Grinding is not a process for a new machine tool—the exclusion of dust from the slides is a difficult if not impossible task, but on a machine rapidly approaching the day when the book value is negligible, the introduction of such an operation is less likely to have the same serious results as with a new lathe.

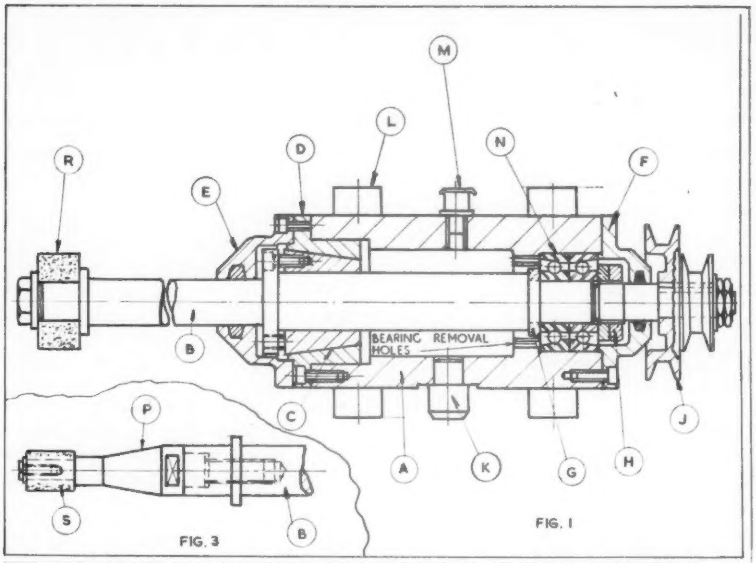
Limitations are expected with this type of equipment, but applied intelligently it gives excellent results and justifies the initial manufacturing costs. Some thought is therefore necessary before embarking on the design, and a brief survey of past work undertaken on that particular machine is essential because the information is useful in determining the speeds of the grinding wheel.

For the heavier type of lathe for which the original version of this attachment was designed, two wheel sizes of about 2 and 4 in. were deemed suitable sizes, and the adoption of a V-drive by means of the two step pulley J ensured that no chatter occurred in the bore of a component as in the case of flat belts with the usual style of joint.

Fig. 1 illustrates this grinding spindle and emphasis is placed on one important factor—with the exception of the minor items such as screws and packing material, all parts forming the construction are made from scrap and no castings are necessary. Fabrication of the base member A depends largely on the type of tool holder or top slide on the lathe, and for extra rigidity it might be advisable to drill and tap further holes to give a direct clamping action rather than rely on the usual clamping method. If this arrangement is adopted the tapped holes are plugged with socket grub screws to prevent swarf from entering and clogging the threads. Similarly the spigot K locates the base member if a hole is drilled and reamered in the lathe cross slide—generally alignment is possible without resorting to a tenon locating in a slot or other form of location, and to achieve perfect alignment would necessitate accurate and lengthy setting off the machine centre line.

The fabricated base is merely a length of circular bar with four smaller rods welded at right angles, and if these latter pieces are shaped to create a seating then a generous weld along both the upper and lower edges is strong enough to make a rigid assembly.

Depending largely on the size of the equipment, the method of manu-



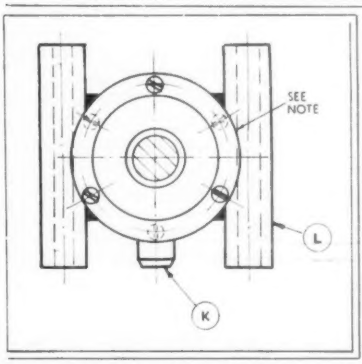


Fig. 2.—End elevation of the assembled spindle showing how the feet are shaped to fit round the body detail

Fig. 1.—Tapered style of front bearing which is easily adjusted by means of the grub screws after the front cover has been removed. Fig. 3.—Extension spindle fitted into a pilot bored in the front end of the grinding wheel main spindle.

facturing this item is not difficult. For massive parts the boring machine is an obvious solution, but a milling machine set up with a stub arbor also makes a simple process. On both machines the best method is to bore right through each hole and thus ensure that they are in line and not to rely on initially completing one bore and then reversing the base on the machine table for the opposite end.

Smaller bases are fairly easily handled on the lathe—in fact if the feet are afterwards milled, a four-jaw chuck makes an ideal holding medium while the bores are completed.

The first grinding spindle made to this design was constructed with ball races at the front end, but this unfortunately led to slight but readily apparent chatter marks appearing on the ground surfaces. The inclusion of a long spindle with a small wheel no doubt aggravated this condition, so it was decided to replace these with a plain tapered bearing with phosphor bronze housing. The drawing shows how this was accomplished by adding the tapered portion C to the shaft B and boring the body to suit the housing D, and two double purpose thrust bearings at the opposite end finalised the arrangements for this portion of the design. Making the bearings in two parts in this way is almost the identical method as practised by the Milnes lathe makers in their light type pre-war machines, and with correctly machined tapers this form of bearing is highly efficient. It also permits close adjustment of this front unit without disturbing the rear races simply by slackening off the three socket headed screws and tightening the grub screws. For this work the front cover E is removed to uncover the spindle flange.

Two locknuts H tightening against the ball races and thence to the steel collar G hold the rear end of the spindle, and the cover F which is almost a replica of the front detail E has the usual felt oil seal to prevent leakage and at the same time prevent grinding dust from entering the bearings.

Adequate lubrication to both bearings is obtained by boring out the centre of the body to form an oil reservoir and a generous quantity poured into the attachment ensures that the bearings are thoroughly lubricated for long periods and that frequent attention is not necessary.

A refinement well worth consideration is the installation of the extension spindle for the very diminutive grinding wheels and a suggested design for this accessory is seen at Fig. 3. The wheel is fixed to the spindle in the conventional manner and to obtain true running the end of the spindle B is bored out to the outside diameter of the tapped hole to provide an accurate pilotage for the new extension. Two flats on the latter makes removal easy.

One final point worth mentioning concerns the two holes drilled behind the races for removing them should at any time this be necessary. They overcome the practice of tapping the spindle and so possibly damaging the rings, and long pieces of silver steel inserted in the holes eject the races without difficulty.

Holding a Component with a Short Bore

Components that have a short length of bore as a locating medium in contrast to the long and frequently large outside diameter usually provided, require additional facilities incorporated in the fixture to ensure that the part rotates truly and does not assume the "drunken" appearance usually observed when a previously machined rim or face commences to rotate.

If the production of a workpiece demands that the outside diameter and front surfaces are machined at a single setting, clamping is generally impossible and reliance on the expanding type of spigot becomes necessary. A location of this design does not provide a substantial drive—in fact really deep cuts will usually cause the component to cease rotating and there is thus the risk of fractured tools or a bent spigot, so if there is a hole or aperture in one of the faces which can act as a driving medium, this can be used to overcome the difficulty. However, when no alternative is possible, only light cuts with a corresponding reduction in the feed will enable an operator to complete the machining, and this was necessary with the workpiece depicted at Fig. 1.

The initial operation of boring the location hole, recessing, opening out and threading the bore and turning the outside diameter as well as facing the front face, were all performed on a turret lathe at a single setting using a chuck for holding.

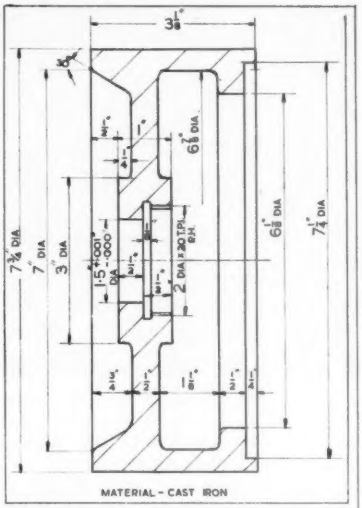


Fig. 1.—Pulley type castings having a short bore are typical examples where this class of equipment will find a ready use. The secondary process is essential because of the tapered portion seen at the left

The inclusion of a taper inside the casting precluded holding it from inside and thus competing the latter process at a single setting, so it was necessary to locate from the short hole in the manner seen at Fig. 2 and support the casting high up and just inside the recess at what is the front end during the initial turning stages.

Expansion of the spigot is determined in the usual way—a tapered inner member being pulled toward the machine headstock and thus causing the spigot to grip the bore. These two details are denoted on the drawing by the letters A and B, and the action of pulling back this spigot makes it seat against the spring-loaded member C until clamping eventually occurs.

During the process of locking the taper from the rear end of the machine spindle, the component is pressed back against the flat disc D and to assist this a specially constructed pad held in the turret is used as this exercises an even pressure round the article and does ensure that it seats properly.

The extension of the tapered spindle A outwards from the component is useful in that it ensures the centralization of the expanded member. The seating of the face against the disc C and the fitting on the taper which, of course, also locates closely inside the detail D, all assist in setting the location accurately in line with the machine spindle and secures concentricity.

Spring loading the centre disc C is essential otherwise the collet B would not lock efficiently and the end on this disc spreads the collet to provide adequate gripping at that end. The degree of movement against the rather heavy springs allows the collet to open to cause a tight grip in the bore of the component.

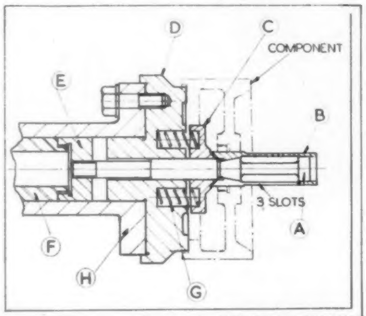


Fig. 2.—The expanding type collet and the friction imparted by the large disc is enough to drive the component if care is used when applying the feed

The remaining parts E and F are the draw nut and spindle that passes through the machine spindle in the same way as the orthodox collet closing member. The nut, as the illustration shows, is threaded on the spindle and is either secured by a pin or grub screw.

The friction of the disc D acting on the casting, and the pressure of the collet detail, are sufficient for the operation of turning the top diameter and facing the remaining surface if a slow feed is employed, but the casting has to be watched carefully to see that it does not stop rotating. If this practice is followed a setting of this nature is satisfactory and accuracy is assured.

Collet Type Gear Cutting Fixture

There are occasions during design when simplification in an endeavour to reduce production costs on one particular operation can often lead to elaborate tooling at some later stage due to the omission of a simple process, and the stub gear shown in Fig. 1 is an example where this lack of foresight occurred and it became necessary to design and manufacture a special gear cutting fixture instead of using the standard equipment applied for so many similar parts.

Generally, during gear cutting the provision of a boss lifts the face of the gear sufficiently high above the chuck or collet to provide clearance for the descending cutter to pass over the teeth, and though the space would normally soon fill with swarf, the flood of coolant removes the chippings.

When such a boss is lacking in the design it becomes essential to create some alternative stop surface which will take the cutter thrust, and with the component depicted here the only site is the end of the spindle.

Facing the end of a component of this nature is not difficult. If no rotary grinding operation follows the initial turning, then the end is merely faced to length while the part is still attached to the bar. However, when accuracy demands it the diameter is sized to close tolerances and this provides an opportunity to grind the end at the same setting by using a half centre which permits a grinding wheel to approach the centre of the machine line.

The gear cutting fixture follows orthodox practice except, of course, that the base is provided with a stop against which the blank rests, but to accommodate various components of similar size to that shown, a bush A is used to locate the shank diameter while the provision of grooves causes it to close and securely hold the piece.

The collet B fits the base D. Both the bore of the latter and the outside of the collet are ground to slide easily and the action of cap C pushing downward on the taper is enough to effect closure of both the collet and bush and so hold the gear blank. Not much pressure is needed for this as the cutting action does not set up a high radial pressure, and the use of a tommy bar is adequate for all but the larger gears.

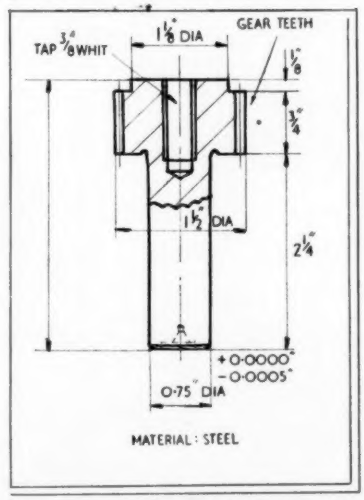


Fig. 1.—An apparently simple-looking spur gear which had been designed for cheap production but which presented a problem when machining the teeth

Swarf can drop into the collet slots when the latter is released and the component removed, and to exclude as much as possible a sheet metal guard F is brazed to the underside of the bush A and extended to shed the chips as they are machined from the blank.

The stop E in the base of the fixture locates in the same hole as the collet, and is initially tightened by means of the flats milled on the flange; afterwards the flange is pinned to prevent vibration causing it to slacken and thus altering the vertical setting of the gear in the fixture. The setting is not critical, but small refinements of this nature add to the efficiency of tooling equipment.

This gear cutting fixture was originally fitted to a Maag gear cutting machine, hence the slightly tapered location that fits in the machine table. The inclusion of such a taper demands additional care during grinding because the flange does not seat exactly if the tapered diameter is even a matter of a few ten-thousandths of an inch oversize. Socket headed screws hold the fixture to the machine table.

Despite the swarf guard chips will undoubtedly find their way to the

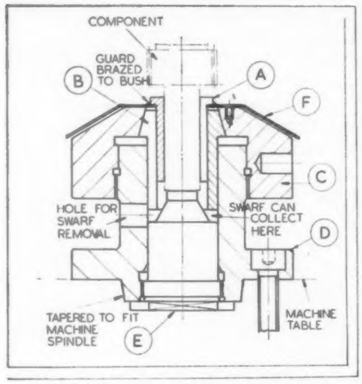
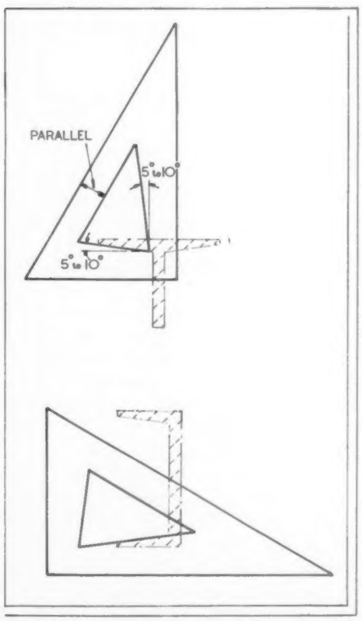


Fig. 2. Collet type gear cutting fixture designed for machining a variety of components by changing the bush and lower stop

lower location unless they are cleared from the vicinity of the collet immediately cutting is complete, and if they are brushed or washed away with a flood of coolant before releasing the gear, the possibility of any reaching the top surface of E is remote. Incidentally, the sides directly beneath this face are angled away to provide a deep pocket into which any chips can fall, and the drilling of three holes through the side walls means they are easily scraped or washed from inside the fixture.

Set Square for Drawing Draught Angles

A further addition to the large number of different aids for a draughtsman is seen in the sketch—this time for those engaged chiefly on structural steel work—but the idea is also applicable to others where a draught angle is a feature in their various designs.



Set square for drawing angles in constructional steel work

A solid set square is preferred for this purpose and if the centre is cut away on at least two sides as shown, the necessary angles are quickly drawn with the same square which is used for the vertical lines.

Generally a somewhat exaggerated angle is best because it emphasises the taper or draw on an assembly drawing, and as a small scale is usual for work of this type, this extra angularity gives prominence to the shape. From 5° to 10° is therefore used, and anything smaller is almost a vertical line when the length of line is in the region of ½ in.

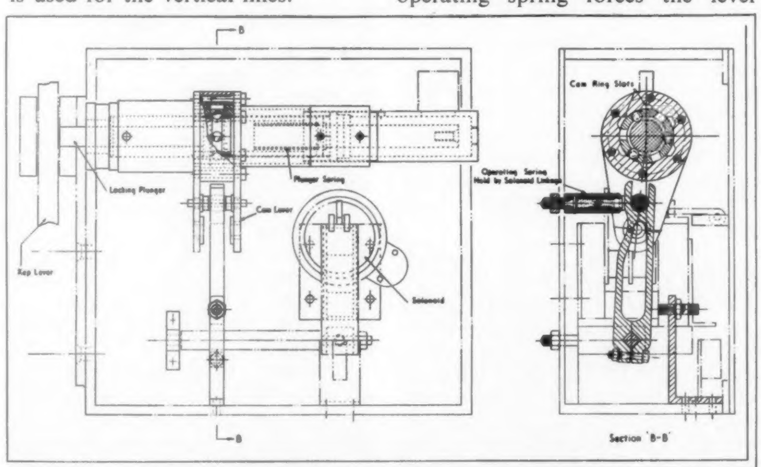
A paper template glued to the set square is a useful and quick guide when cutting out the aperture, and a smooth file soon removes the saw marks.

Kep Locking Device

A locking device to prevent the withdrawal of cage keps when slack rope occurs, now in use at Ollerton Colliery in the N.C.B. East Midlands Div, has been developed by Mr. W. J. Pearson, Unit Mechanical Engineer at the colliery, and Mr. J. Leaman, Group Mechanical Engineer in the Division's No. 3 Area.

The device consists of a spring-loaded plunger which in action locks the kep operating lever, preventing any movement of the lever into the "keps out" position. Under normal working conditions the plunger is held clear of the locking position by a solenoid-controlled linkage. Application of the slack rope alarm breaks the electrical circuit, de-energising the solenoid and bringing the locking plunger into action.

In the illustration the plunger is shown in position for normal working. It is held clear of the locking position by steel balls around which the cam lever rotates. The cam lever is held in the position shown by the solenoid through a series of linkages; when the solenoid is de-energised the operating spring forces the lever



Kep locking device. Plunger is shown positioned for normal working

Herbert file testing machine

through an angle of 30°. This brings the slots in the cam ring into line with the steel balls which are then forced outwards into these slots by the action of the plunger spring. The plunger is then free, under the action of the spring, to pass forward through a locating hole immediately in front of the kep operating lever. At the same time an alarm is sounded in the banksman's cabin and the winding engine house, indicating that the keps are locked and preventing further winding until re-set.

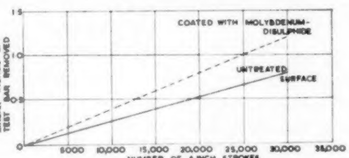
Re-setting is carried out by taking up slack rope, removing a plug from the end of the locking plunger sleeve and inserting a screwed rod into the end of the locking plunger. The plunger is pulled to the re-set position, thus completing the electrical circuit and energising the solenoid.

File Efficiency Increased by MoS_2 Treatment

Tests carried out jointly by two companies in the B.S.A. Group, William Jessop & Sons Limited, and J. J. Saville & Co. Limited, well-known Sheffield steel and tool manufacturers, have shown that molybdenum disulphide treatment of files can improve their cutting efficiency by as much as 60%. A 'dag' dispersion of colloidal molybdenum disulphide supplied by Acheson Colloids Limited, was used throughout the tests.

The idea of coating file cutting faces with a dry film lubricant was first suggested by an Acheson engineer early in 1957, following favourable reports of a private individual's experiments. The suggestion was submitted to the Jessop-Savill Organisation's Research and Development Department and it was agreed that thorough tests should be conducted.

Spraying a file with 'dag' Product 1127 (colloidal molybdenum disulphide in alcohol)



Test results obtained with 12-in. smooth files

One batch of 12 in. hand bastard files (most commonly used engineers' file) were spray coated with 'dag' Product 1127 (colloidal molybdenum disulphide in alcohol) and others with 'dag' Product 1209 (colloidal molybdenum disulphide in toluene), each diluted with toluene to a suitable spraying consistency.

After the teeth of a file have been cut, it is hardened by heating and then quenching in brine. Because the file must be as hard as possible, no tempering treatment can be carried out. For this reason it was not possible to heat-cure the coating formed from Product 1209 and files treated with this material showed no improvement. Therefore Product 1127 which requires no subsequent heat-curing treatment was used in later tests.

Encouraging results were obtained when the 1127-treated files were tested on the Herbert file testing machine. In these tests, each file face was rubbed 30,000 times on a steel bar under a constant pressure. The amount of steel removed from the bar is a measure of the file's performance.

To confirm the favourable results obtained from the treated 12 in. hand bastard files, further tests were carried out with 12 in. hand smooth files and 6 in. three-square engineers' files (triangular cross section), each type having a finer cut than the 12 in. bastard. Even better performances were obtained: 50% increased efficiency with the smooth and 60% with the three-square files. The results revealed that the percentage improvement varied with the fineness of the teeth. This was attributed to the fact that the treated teeth did not clog as much as usual, the 1127 coating apparently acting as a kind of parting agent between the filings and teeth. Jessop-Saville believe that the treatment will be of particular value for smooth files, especially when used on difficult "clogging" metals.

A valuable incidental advantage of the treatment is the good appearance of the sprayed file, which is a definite selling point. Furthermore, from preliminary tests carried out, the protection the coating provides against corrosion does not appear to be inferior to that offered by materials in current use.

The following are extracts from test data issued by the Research and Development Department of the Jessop-Saville Organisation:

"Six files, three sprayed and three not sprayed, were tested in the Herbert file testing machine. The test conditions employed were as follows:—

For 12 in. hand smooth and hand bastard files

1 in. square test bar having a Brinell hardness of 187.

6 in. cutting stroke at a rate of 55 strokes/min.

31 psi pressure on file work area.

For 6 in. three-square engineers' files

1 in. × ½ in. test bar of 235 Brinell number.

3 in. cutting stroke at a rate of 55 strokes/min.

31 psi pressure on file work area.

Results

TABLE I

Type of file	*Nature of file surface tested*	*Linear inches of 1 in. square test bar removed after 30,000 strokes*
12 in. hand bastard	Untreated	9·0
12. in. hand bastard	Sprayed with 'dag' 1127	10·2
12 in. hand smooth	Untreated	0·8
12 in. hand smooth	Sprayed with 'dag' 1127	1·2

TABLE II

Type of file	*Nature of file surface tested*	*Linear inches of 1 in. × ½ in. test bar removed after 30,000 strokes*
6 in. three-square Engineers' files	Untreated	0·6
	Sprayed with 'dag' 1127	1·0

Stoker Firing for Locomotives

Three 2-10-0 Class 9F locomotives fitted with Berkley stokers

OVER the years railways have been confronted with the problem of increasing locomotive capacity and it is generally recognised that the power developed is limited by the physical effort of the fireman. Mechanical firing has received attention over a considerable period of time and has resulted in the development of several types of mechanical stokers. The fitting of stokers to locomotives is not necessarily dependent upon the size of grate but aims at obtaining maximum output from the boiler at all times regardless of the working of the locomotive and quality of fuel.

The Berkley stoker, which includes a number of novel features that have proved successful in operation in other countries, is not automatic and has to be intelligently controlled for efficient operation. It does however relieve the fireman of heavy physical labour. Three British Railways Standard 2-10-0 Class 9 freight locomotives Nos. 92165, 92166 and 92167 recently constructed at the Crewe Works of the London Midland Region have been fitted with Berkley stokers under the direction of Mr. R. C. Bond, Chief Mechanical Engineer, British Transport Commission. The stoker as fitted to these locomotives consists of four main units, the engine or power unit, tender conveyor unit, intermediate conduit and riser conduit.

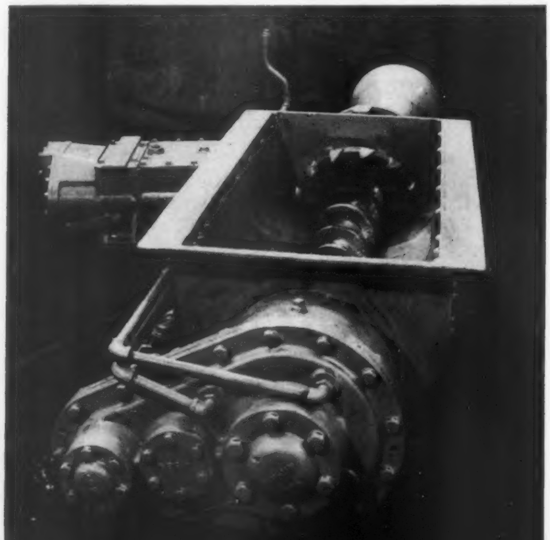
Footplate of Class 9F locomotive fitted with Berkley stoker, showing the riser conduit and screw with its joint for connection to the intermediate screw. On the right are the cocks controlling the steam jets which distribute the coal in the firebox

The engine, which is mounted on the tender front dragbox, provides the necessary power under all conditions to supply coal to the firebox, and can be throttled down to furnish the coal as sparingly and continuously as required. It is possible to work the engine in reverse in case of a blockage in the stoker mechanism.

The tender conveyor unit consists of a trough, conveyor screw, crusher and gearbox. The trough is located below the coal bunker and is mounted on rollers to take care of the movement between engine and tender. The power from the engine unit is transmitted to the gearbox mounted at the rear of the conveyor unit by means of a slip shaft with universal joints. The gearbox transmits motion to the conveyor screw which carries coal from the bunker through the crusher, where it is broken down to the correct size and is then fed into the intermediate conduit.

The intermediate conduit includes a conveyor screw enclosed in a conduit or casing, which is connected to the riser by a special ball joint.

The riser conduit, which extends upward through the footplate and is secured to the back of the firebox, includes a further conveyor screw which is connected to



The tender conveyor unit, showing trough, conveyor screw, crusher, and gearbox. The stoker engine can be seen on the left

the intermediate screw by means of a universal joint. The riser screw has a reverse flight at the extreme end and this results in the coal being levelled down and spread out prior to delivery into the firebox, thus ensuring a uniform delivery of coal over the distributor plate fitted above the hooded jet plate, and located at the underside of the firehole.

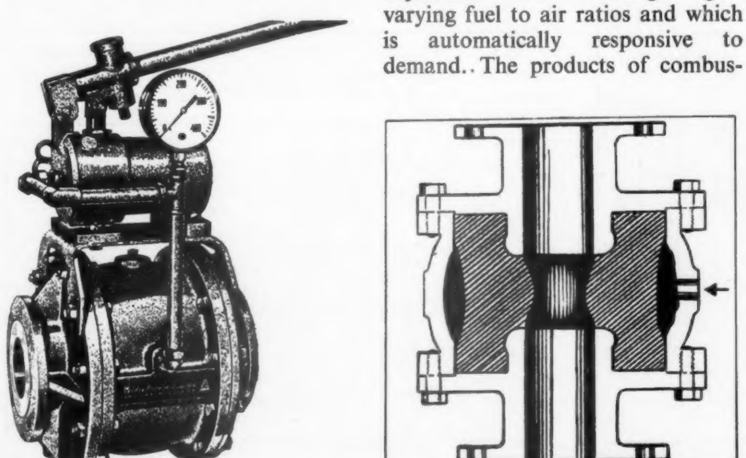
The jet plate fits in the lower portion of the mouth of the riser conduit and means are provided for easy adjustment to the proper firing angularity. The front of the jet plate has hoods over the jet orifices which allow divergence of the steam jet before meeting the coal, thus ensuring efficient distribution over the grate. The jet plate is divided into four compartments, each controlled by a separate valve located in the jet manifold and marked to indicate which section of jets the valve controls, i.e. left front, right front, left back, right back. Pressure gauges are located on a panel in the cab. In the case of the right and left hand gauges the black hand indicates jet pressure for the back corners and the red hand indicates jet pressure for the front of the firebox. The centre gauge shows the stoker engine pressure. The jet casting is protected from the heat of the fire by a protecting apron held in place by a removable pin.

With this form of stoker it is possible to adjust independently the coal feed and the steam jet pressures and thus obtain an even distribution of coal in the firebox under all conditions. It is possible to hand fire the locomotive in case of failure of the stoker or when it is necessary to correct the firebed after removal of clinker, etc., and also when working the locomotive on comparatively short journeys where time would be insufficient to allow correct setting of the coal feed and jet pressures of the stoker.

Maintaining Circular Flow Control by Diaphragm Valve

Now available for the first time in this country the Sala control valve is unique in that the flow constriction area remains a round hole for all stages of valve opening. These valves are particulary suitable for handling abrasive slurries where the low friction of the Venturi flow pattern through a round hole reduces abrasive wear and risk of valve stoppage.

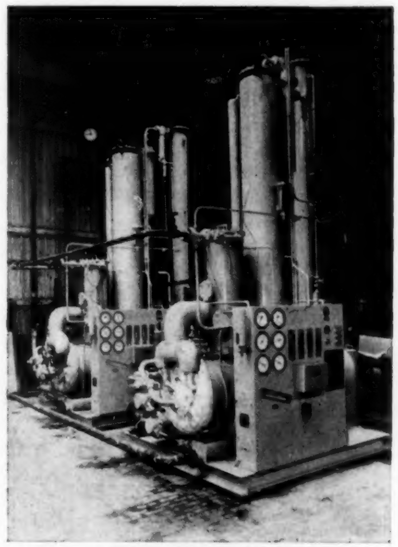
The adjustment of the diameter of the valve is controlled through a hydraulic pressure operator which can either be mounted on the valve as illustrated or installed elsewhere for remote controlling. Castor oil is used as the hydraulic medium. The diameter of the valve is proportional to the hydraulic pressure on the outside of the rubber bushing so that a pressure gauge will serve as an indication of the valve opening. Whilst the Sala rubber valve can be totally closed, its main purpose is one of flow control and complete shut-off is not recommended except for short periods. Sala valves in 1½, 2, 3 and 4 in. bore sizes are available from Neldco Processes Limited, Ashford, Middlesex.



Left, Sala diaphragm valve with hydraulic control. Right, cross section of the diaphragm

Self-contained Nitrogen Generator

Capable of producing nitrogen by the combustion of any of the commercial fuel gases with air, the Holmes-Kemp nitrogen generator is almost entirely automatic in operation.



Holmes nitrogen generator

Controlled combustion is achieved by the use of a carburettor which is adjustable over a wide range to give varying fuel to air ratios and which is automatically responsive to demand. The products of combustion are cooled and carbon dioxide removal is then carried out by passing the gas through an adsorber tower containing monoethanolamine. The plants are completely self-contained and continuous in operation with re-boiler, stripper and heat exchanger for the re-generation of the monoethanolamine.

A nitrogen compressor is usually provided to enable the gas to be stored at pressure. Where necessary a Holmes-Kemp dryer can be included to ensure freedom from moisture. Plants of the type illustrated, the first two manufactured in the U.K. by W. C. Holmes & Co. Limited, P.O. Box No. B7, Turnbridge, Huddersfield, are available in capacities up to 20,000 cfh nitrogen.

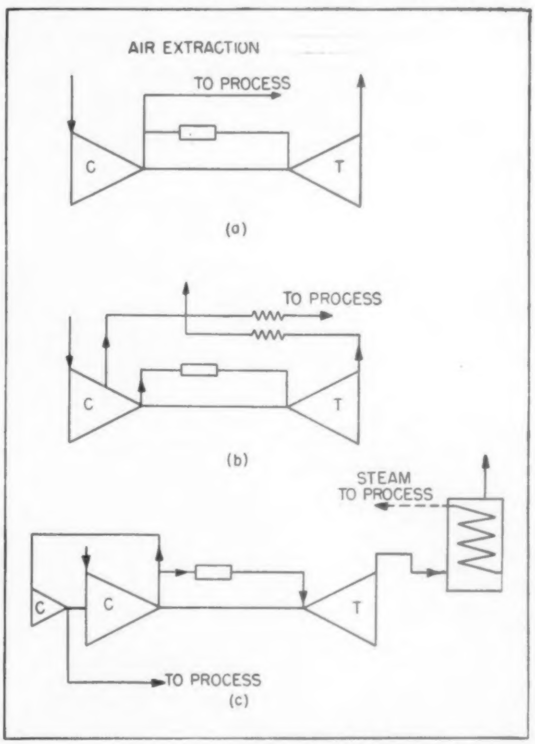
Operating Experience with Gas Turbines

Industrial gas turbine installations are working in many parts of the world and information is becoming available regarding operation and maintenance. The following notes have been collated from a number of sources

By LEO WALTER, A.M.I.Mech.E.

DURING the last five years commercial gas turbine installations have ranged from 1000 to 20,000 kW, driving large gas compressors in areas where natural gas is present, generating electric power, providing mechanical drive, and last but not least for process purposes. The possibility of generating process steam and obtaining electric power as a by-product has introduced the gas turbine into chemical processing, and vigorous development in this field seems in prospect. Another development which may be confidently expected in the future seems to be the use of the closed-cycle gas turbine for nuclear power generation. This would obviate the use of heat exchanger towers and of steam turbines. A number of papers have been published during the last five years on the subject of this survey, and brief excerpts will be given in the following.

C. J. Burke of Westinghouse (see Bibliography) has dealt with the use of gas turbines for natural gas transmission. The centrifugal natural gas compressor allows of lower compression ratios by reducing the station spacing and the horsepower necessary to transport a given amount of gas can be reduced 25% to 40%. Comparative figures for gas turbine and reciprocating



International General Electric Corporation

Fig. 1.—Diagrams showing air-extraction cycles for gas turbines. T, gas turbine C, air compressor

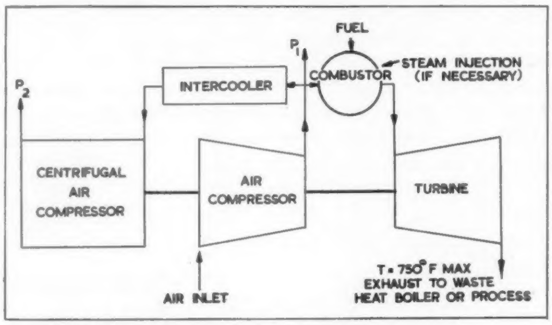
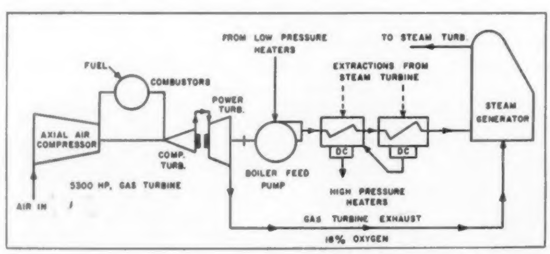
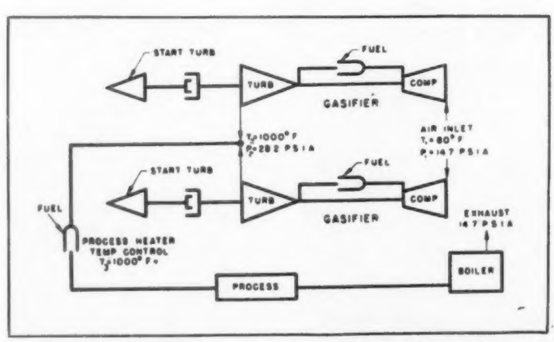


Fig. 2.—Gas turbine for supplying two levels of process air



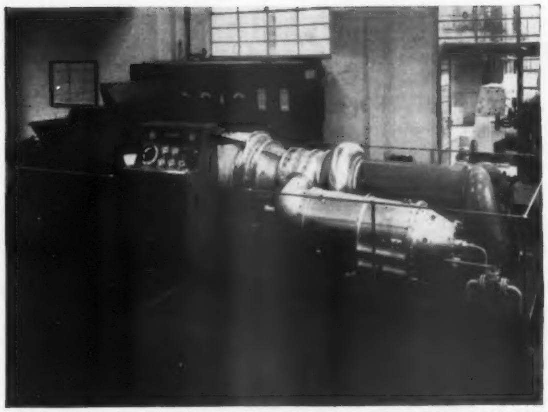
Westinghouse Electric Corporation

Fig. 3.—Gas turbine for driving boiler feed pump and supplying part of combustion air for steam generator



Westinghouse Electric Corporation

Fig. 4.—Diagram of gasifier application. Two gas turbines use common discharge for catalyst regeneration in a butadyne process. Note process heater in gas exhaust



Ruston & Hornsby Limited

Fig. 5.—Ruston TA turbine for A.G.I.P. This set has over 18,500 hr

compressors much favour the turbine. The use of gas turbines for driving pumps, blowers, compressors, etc., for general process applications is not only economical but of great operational advantage due to the great flexibility obtained in (a) ability to instal additional plant without having to increase existing boiler capacity, (b) the possibility of efficient exhaust steam utilization for process purposes, feedwater heating, space heating, air conditioning and the like, and (c) independence of outside conditions such as climate, cooling water, etc., excepting fuel.

Chemical processing

Where waste gases from chemical processes can be utilized in the combustion chamber of a gas turbine plant, fuel costs are definitely competitive with any other prime mover. In addition to the possibility of exhaust heat recovery in steam boilers supplying process steam, the gases can be utilized as heated combustion air/gas mixtures (high in oxygen content) for process furnaces or boilers.

Hafer and Wilson of the General Electric Company, Schenectady, have described operational experience from a total of 99 gas turbines. These units have accumulated well over 800,000 hours of operation. As an example, an American G.E.C., 5700 hp simple-cycle is driving three centrifugal compressors in a plant of the Standard Oil Company. A single-shaft design was chosen because very little speed variation was required. The gas turbine discharges into an unfired exhaust boiler and amongst other process applications is air extraction. Fig. 1 gives diagrams illustrating air-extraction cycles.

Use in the process industries

Over one-third of industrial gas turbines supplied by Westinghouse Electric Corporation, Philadelphia, Pa., are in use in process industries. Frame horsepowers are 3250 to 22,500 and among them is the Model W.81B supplying exhaust gas to process at the rate of 98,000 cu ft/min at about 28.2 psia and 1000°F. Air to process is supplied from model W201E at the rate of 125,000 cu/ft at 35 psig and 355°F. The rating for the corresponding types for mechanical drives is, for model W81M 7800 frame hp, and for W201M 22,500 hp. Figs. 2 and 3 illustrate two examples.

Amongst Westinghouse units in operation is one 3000 hp and two 5000 hp turbines used for compressor drive in catalytic cracking plants. (Fig. 4).

It is of interest to note that in specifications by various oil companies a common statement for gas turbine drive in catalytic cracking plants is that the prime mover must be capable of operating for two years without shutdown. Practice has shown that this can be achieved, and repeat orders confirm this.

Operating experience with Ruston type units

One of the leading firms in U.S.A. manufacturing gas turbines for industrial use are Clark Bros. Company, New York. Their Models 305 and 302 rated at 8700-9300 bhp are used for driving air compressors, for drying or for catalyst regeneration, for pump drives, etc. It speaks well for a British design that Clark Bros. have taken out a manufacturing licence from Ruston & Hornsby Limited, of Lincoln, for their Mark TA Ruston gas turbine. Feilden and Latimer have discussed operating experience with gas turbines burning natural gas, distillate and crude fuel oils. The operation of 29 Mark TA Ruston gas turbines in service has been noteworthy for freedom from blade breakages or other major failures. Service troubles have been confined to auxiliary equipment and will be eliminated by further development work. The turbine at the Cortemaggiore oil refinery has completed over 18,000 hr of operation on natural gas fuel. From July 28, 1955, up to September 30, 1956, it showed an overall availability of 98.5%. A vane failure occurred on the AGIP unit, and although the turbine carried on, the damaged rotor was replaced during a refinery shutdown after 1700 hr total run. Another incident occurred after 9580 hr total running time, when a slight change of noise was noted in the epicyclic gear. A prolonged refinery shutdown gave, after 9580 hr total running time, opportunity for inspection and a piece ¾ in. long was found to have broken away from a tooth, making repair essential. The set is shown in Fig. 5.

A four-turbine power plant at Cementos Carabobo in Venezuela went into service in October 1956 and has been run alternately in pairs or three at a time since. Only one incident occurred, caused by wrong synchronization. A shaft distortion in the low-pressure turbine resulted, which necessitated its replacement later.

Experience has been gained with oil-field applications in Kuwait and at various sites in Saudi-Arabia for ARAMCO. A mishap occurred in gas turbine No. 2 at Safaniya, 140 miles from Dhahran, caused by a faulty liquid separator mounted in the gas feed. It allowed at least 5 gal of natural gasoline to pass into the turbine as a single slug. The resulting explosion damaged the blading. Replacement turbine rotors and stators were flown out to Safaniya within four days and shortly afterwards the turbine was again ready for work.

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Thermonuclear Fusion—A Glossary of Terms

THERMONUCLEAR fusion will before long acquire a technological aspect. It will bring with it a collection of terms, many of which are not widely known. The glossary printed below is due to the Union Carbide International Company, of New York.

Bremstrahlung. Radiation emitted by an electron decelerated by the field of a heavier charged particle. Since some of the energy lost appears as X-rays, the energy of these rays indicates the energy of the electrons in the plasma.

Cloud chamber. An enclosure containing air supersaturated with vapour in which rapidly moving particles are revealed by streaks of droplets called *cloud tracks.* (Also known as a Wilson chamber.)

Coulomb collision. Deflection of one charged particle by the electric field of another, in which the particles do not touch.

Coulomb barrier. The electrostatic barrier or "hill" associated with the electric field surrounding a charged particle.

Controlled fusion reactor. Device within which appropriate isotopes of light elements can be caused to undergo nuclear fusion, the end result being the controlled production and extraction of useful quantities of energy in excess of that required to operate the device.

Containment time. Time durng which the density of the plasma does not undergo substantial change.

Constriction instability. Instability accompanied by the constriction of the radius of the discharge.

Completely ionized plasma. A plasma in which the positively charged particles are completely stripped of orbital electrons.

DT. Symbol for the deuteron-triton reaction.

Debye sphere. A sphere whose radius is a Debye length.

Debye length. In an ionized medium or plasma a characteristic distance from any randomly chosen particle A beyond which other charged particles are effectively shielded from A.

DD. Symbol for the deuteron - deuteron reaction.

Deuterium. An isotope of hydrogen having an atomic weight of 2.

Divertor. A device for preventing the particles from touching the walls.

Diffusion time of a particle in a plasma. Average time required by a particle moving across the magnetic field to pass through the confining space.

Electron-volt. A unit of energy used to express the temperature of ions or electrons in an ionized gas. One electron-volt is equivalent to about 10,000°C.

Fusion reaction. A nuclear reaction where light nuclei are combined to form heavier nuclei.

Gauss. Unit of magnetic field strength.

Impurity atom or ion. Particles, other than the fusion fuel, which tend to cool a hot ionized gas, or prevent it from reaching high temperatures.

Infinite sheet of plasma. A plasma which may be called "endless" in that it closes upon itself.

Interchange. A type of *instability* in which the ionized gas and the surrounding magnetic confining field tend to exchange places.

Ion, positive ion. The charged particle formed when one or more electrons are removed from an atom or molecule; often, specifically, the positively-charged nucleus of a heavy-hydrogen atom, capable of fusion.

Ion cyclotron frequency. Frequency of revolution of an ion in a given magnetic field.

Ignition temperature. Temperature at which a self-sustaining thermonuclear reaction can be maintained.

Kink instability. Instability where the magnetic lines are crowded on the concave side of the containment region.

Magnetic bottle. A configuration of magnetic fields for containing the plasma.

Magnetic field. The property of space whereby electric currents exert a force on charged particles, causing them to move in helical or corkscrew paths.

A **magnetic field line** is an imaginary line indicating the direction of the magnetic field.

Magnetic mirror. Region of space in which the magnetic field changes rapidly so as to reflect charged particles.

Mean free path. The average distance travelled by a particle in a gas before collision with another particle.

Molecular breakup. Dissociation of molecular particles into atomic particles.

Magnetic pumping. One of the methods of heating a plasma by means of a periodically varied magnetic field.

Neutral instability. An oscillating disturbance in a plasma which does not increase or decrease with time.

Ohmic heating. Heating of a plasma by means of a low-frequency electric discharge.

Plasma. An electrically neutral gas of ions and electrons.

Proton. The nucleus of an atom or ordinary hydrogen having mass 1.

Pinch effect. Constriction of an electric discharge due to the action of its own magnetic field.

Relativistic electrons. Electrons travelling fast enough so that their increase of mass (according to the Special Theory of Relativity) is significant.

Resonance heating. Heating of a plasma at a frequency substantially equal to the ion cyclotron frequency.

Rotational transform. A mathematical property of the twisted magnetic field used in the *stellarator*, which is used to obtain equilibrium confinement of an ionized gas in an endless container.

Shear. A property of a twisted magnetic field whereby the amount of *twist* varies with depth.

Shock heating. A method of heating a plasma by means of a sudden increase of a magnetic field.

Sputtering. A result of the disintegration of a metal caused by bombardment of ions.

Tritium. An isotope of hydrogen having an atomic weight of 3.

Toroidal discharge. An electrical discharge within a cylindrical tube bent into a circle (torus).

Work in Hand at Hinkley Point

Constructional progress on the world's largest atomic power station

CONSTRUCTION of the main biological shield of the first reactor at Hinkley Point Atomic Power Station is half completed and the shield now stands 50 ft above general station level. Work on the foundations of the shield began in mid-January, and, by July, 13,000 cu yd of high-quality concrete had been placed in the shield and foundations.

Work on the station, which is being built by The English Electric—Babcock and Wilcox—Taylor Woodrow Atomic Power Group and will be the world's largest (500,000 kW) atomic power station when it comes into operation in 1962, is going forward according to schedule. Approximately 1,200 men are now employed on the site. The foundations of the biological shield for the second reactor, on which work was started towards the end of June, are also nearing completion; some 3,000 cu yd of concrete have been placed to date.

Some 30,000 cu yd of rock excavation has been carried out on the main foundations of the two reactors. Deeper excavations for the foundations of the reactor blower houses are still proceeding. The contract starting date for the station was December, 1957, and the initial task on the site involved the removal of 200,000 cu yd of soil and clay excavation. By the use of fast moving scraper equipment, this was practically completed by early January. The reinforced concrete subway for conveying the high voltage cables from the turbine house to the 275 kV switchgear compound south of the main station site is well on the way to completion. To ensure all-weather access to the whole site, roads and associated services have been rapidly constructed, being mainly complete in May. Extensive workshop and stores buildings have been constructed west of the main station site to provide facilities for site fabrication of heavy equipment such as steam raising units, reactor pressure vessel, etc.

Reinforced concrete foundations are complete for the 250 ft gauge track to carry the 240 ft high Goliath crane capable of lifting 400 tons. Preparations for the erection of this giant crane are in hand.

Heavy plant and equipment will be brought from the works (in Scotland and the North) to site mainly by sea. At Combwich, some four miles from the main site, a wharf capable of handling ships of up to 1,500 tons has been constructed in six months. The erection of a 45-ton capacity derrick to handle cargoes of pressure vessel plate and steam raising unit sections is nearly complete. A 150-ton capacity luffing crane, the foundations for which have been constructed with the wharf, will be available to lift the heavier loads.

Before construction of the turbine house and cooling water system with its associated pumphouse and tunnels could be started, it was essential to complete a 2,500 ft long sea-wall. Work on this wall began in December, 1957 and is now mainly completed, some 17,000 cu yd of concrete having been placed in tidal working conditions

Work on the heavily reinforced concrete biological shield foundations for the first reactor of Hinkley Point atomic power station, the largest under construction in the world, began in the middle of January and by July 13,000 cu yd of high quality concrete had been placed in the shield and foundations. This picture, taken from the South West corner of the No. 1 reactor building, shows the 7 ft thick secondary biological shield with the primary shield behind it. In the foreground work is proceeding in laying the foundation slabs for one of the gas circulator houses

and 70,000 sq yd of foreshore have been reclaimed in forming this sea defence.

An 18-ft dia access shaft for the tunnels has been sunk 80 ft deep and preparatory work is now in hand for driving the access tunnel. A temporary dry dock in which the cooling water intake structure caisson will be built, and from which it will be later floated to site, is mainly completed on the foreshore west of the main station site. Extensive sea bed surveys for the final positioning of the intake have been carried out this year.

Rock excavation for the turbine house and associated cooling water culverts, began in May and is more than half completed, some 35,000 cu yd of rock having been removed.

In addition to the construction work so far mentioned, it was necessary in the early stages of the contract to build a camp to house construction workers. Accommodation and amenities for some 450 men were completed by March and enlargement of the accommodation and amenities continues.

On the right is the completed Calder Hall A power station and on the left, the first reactor and part of the turbine hall of Calder Hall B

Calder B Nearing Completion

BUILDING and civil engineering work for the United Kingdom Atomic Energy Authority, on the Calder Hall B atomic energy power station is expected to be complete this autumn by the main contractors, Taylor Woodrow Construction Limited. From then, the complicated process of completing the last reactor will be in the hands of the engineers of the Atomic Energy Authority. One reactor has already been handed over to the Authority.

Calder B is adjacent to Calder A, the world's first atomic energy power station, completed in 1956, and the four reactors, with their two turbine halls and the four 300-ft high cooling towers on their flanks, now range in line for half a mile along the banks of the Calder stream.

As Taylor Woodrow began work on Calder A in August, 1953, this landmark in British technical achievement will have been built in just over five years. The project involved 300,000 cu yd of excavation; the laying of 150,000 cu yd of concrete, weighing about 280,000 tons; and the use of 6,000 tons of reinforced steel bar reinforcement. By meticulous pre-planning and close co-operation with the other organisations involved, building has been ahead of schedule throughout, despite pioneer work on the new and unusual civil engineering problems involved.

The erection of Calder B started in mid-1955 and Taylor Woodrow's constructional responsibilities were 40% complete when the Queen inaugurated Calder A in October of 1956. The station is identical to Calder A, involving the erection of two 120-ft high reactor buildings founded on heavily reinforced concrete rafts (130 ft by 107 ft and 11 ft deep), and with extremely close tolerances required on the 90-ft high, 7-ft thick walls of the protective, high-density concrete to the biological shields containing the pressure vessels.

As at the construction of Calder A, all possible devices were adopted which could speed the work while maintaining the high degree of accuracy required, such as the use of specially constructed templates and shutters for the pouring of concrete for the unusual shapes or sizes of lifts required, also the dovetailing of operations with the other specialist contractors and suppliers, so that the installation of mechanical and electrical machinery could take place while civil engineering work went on, without delays to either side.

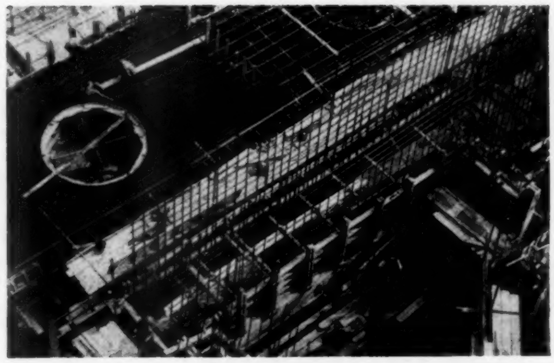
The joint output of Calder A and B stations will be in the region of 180 MW, a relatively small figure in view of subsequent developments and one which bears no relation to the invaluable experience gained for the whole of British industry, or, in fact, for the rest of the world.

At both Calder projects, Babcock and Wilcox Limited were responsible for the heat exchangers—prototypes for those now being built for the Government White Paper nuclear power station programme—and The English Electric Company Limited for certain of the electrical installations. These firms are associated with Taylor Woodrow in the atomic power group whose first joint contract is for the world's largest (500 MW) station, for the Central Electricity Generating Board, on which work began at Hinkley Point, Somerset, in September 1957.

Impermeable Reactor Graphite

Graphite as used to slow down the fast neutrons in a nuclear reactor is a porous material permeable to gases. The graphite manufacturer relies on this permeability to prevent the disruption of his product during the intensive heat treatments associated with the standard graphite making process. Some reactor grade graphites undergo an impregnation treatment which increases the final density but this does not effectively reduce the porosity.

Permeable graphite has several practical disadvantages. In the first place, corrosion by hot gases can occur within the body of the graphite moderator blocks and is not confined to their geometrical surface. In fact, every gramme of graphite exposes nearly half a square metre of surface and in a reactor containing 1,000 tons



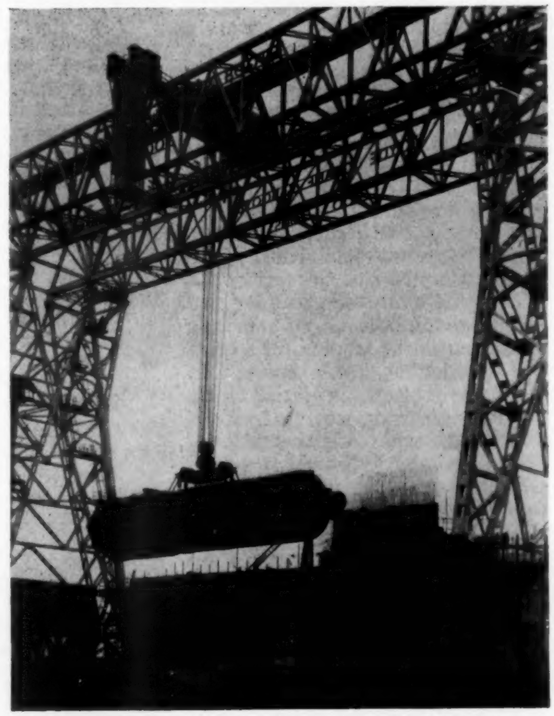
PROGRESS AT BRADWELL-ON-SEA NUCLEAR POWER STATION.—The station will employ two graphite-moderated, gas-cooled reactors and, when commissioned in 1960, will give a guaranteed net electrical output of 300 MW. This power station, one of the first two commercial nuclear power stations for the Central Electricity Generating Board, is being constructed by the Nuclear Power Plant Company Limited. The pictures show a segment of the spherical pressure vessel for No. 1 reactor, being fabricated on the site (each course of the pressure vessels is lifted into position by a Goliath crane) and two of the six boiler supports for No. 1 reactor. The boiler shells 19 ft dia, 87 ft high and weighing nearly 200 tons) are made at Thornaby-on-Tees and floated down to Bradwell, where the Goliath crane lifts them into position

of graphite this surface is of considerable importance. Secondly, the permeability of the graphite permits the escape of gas from the coolant channels in the reactor. An impermeable graphite would permit a design in which the fission products are continuously pumped from the fuel contained within an impervious graphite tube and the coolant gas (outside this tube) remains uncontaminated. This arrangement has very appreciable advantages.

A completely impermeable graphite could have quite novel applications in reactor technology, and could also prove attractive for use in carbon dioxide, water, sodium and hydrogen-cooled reactors. For example, it might be possible to take advantage of the low neutron absorption and extreme heat resistance of graphite and use it as a canning material in place of magnox, beryllium or stainless steel. The brittle nature of graphite could well be a limiting factor, but current research work by The General Electric Company Limited is exploring the mechanical properties of graphites under nuclear irradiation and it may be that this problem will not be as serious as at first thought.

The G.E.C. Research Laboratories have undertaken two development programmes in this field; one to reduce the permeability of existing moderator graphites by an impregnation process, and the other to manufacture a completely impermeable material. In the latter case it has been found necessary to abandon the existing process for making graphites and the carbon atoms are built up in an entirely novel fashion. The first process has resulted in considerable reductions of the permeability of existing graphites and a millionfold improvement has been found possible. In spite of this improvement, however, gas can still enter the interior of this graphite. The totally impermeable material, on the other hand, behaves like a metal and has a gas displacement corresponding to the geometrical volume of the specimen, i.e., gas does not have access to the interior.

In a demonstration at the Atoms for Peace Exhibition at Geneva the company exhibited a tubular element of the new impermeable graphite which was heated by the passage of an electric current. The temperature was maintained at slightly below 600° C so that the tube was just visibly red hot. The interior of the specimen was pressurized with carbon dioxide at ten atmospheres. Research work has shown that graphite does not corrode



Goliath crane lifting one of the heat exchangers into position at Bradwell power station

under these conditions. Since corrosion would rapidly increase the permeability, a demonstration that the impermeable nature is preserved is also a convincing proof of corrosion resistance. To illustrate the low permeability, the specimen was mounted in an evacuated container and the rate of flow through the pump monitored. The pressures inside and outside the specimen were shown on appropriate gauges.

Most applications of a totally impermeable graphite call for a method of welding or joining graphite to graphite, or graphite to metals. The exhibit demonstrated such a joint operating under stress at reactor temperatures and, at the same time, acting as an impermeable barrier to the carbon dioxide gas.

Dual Purpose Machine for Grinding and Fluting Rolls

A combined roll grinding and fluting machine taking rolls up to 60 in. long and 24 in. dia, and auxiliary equipment, including a special driving unit, for the grinding only of rolls up to 32 in. dia is now being manufactured by Thomas Robinson and Son Limited, Rochdale, Lancs. Rolls can be both ground and fluted *in situ*, the change from grinding to fluting being a simple and speedy operation.

The head which carries the grinding and fluting tools is mounted at a convenient height on a base bolted to the bed of the machine to ensure tool rigidity in the correct position relative to the roll. Adjustment for either operation is made by releasing clamping screws in the base and swivelling the complete head on its central spigot. A handwheel which can be locked in any position feeds the head to and from the roll.

The grinding wheel is mounted on a hardened and ground spindle, running in self-lubricating adjustable gunmetal bearings, the spindle being driven by V-belts from a 7½ hp motor mounted on slide rails. The fluting tools are carried in two precision-built tool boxes, mounted at the rear of the grinding wheel and fitted with fine feed screws and graduated collars. A lifting lever fitted to the boxes, worked by stops fixed to the table, lifts the tools off the roll on the backward stroke of the table. Only one tool is required for fluting 13 or more cuts/in., two tools being used when 12 or less cuts/in. are required.

The roll is turned for grinding by a 1½ hp motor rigidly mounted on a swing plate attached to the headstock, using a variable speed V-belt drive to worm reduction gearing which drives the twisting head sleeve and chuck through a dog clutch. This clutch is disengaged when fluting.

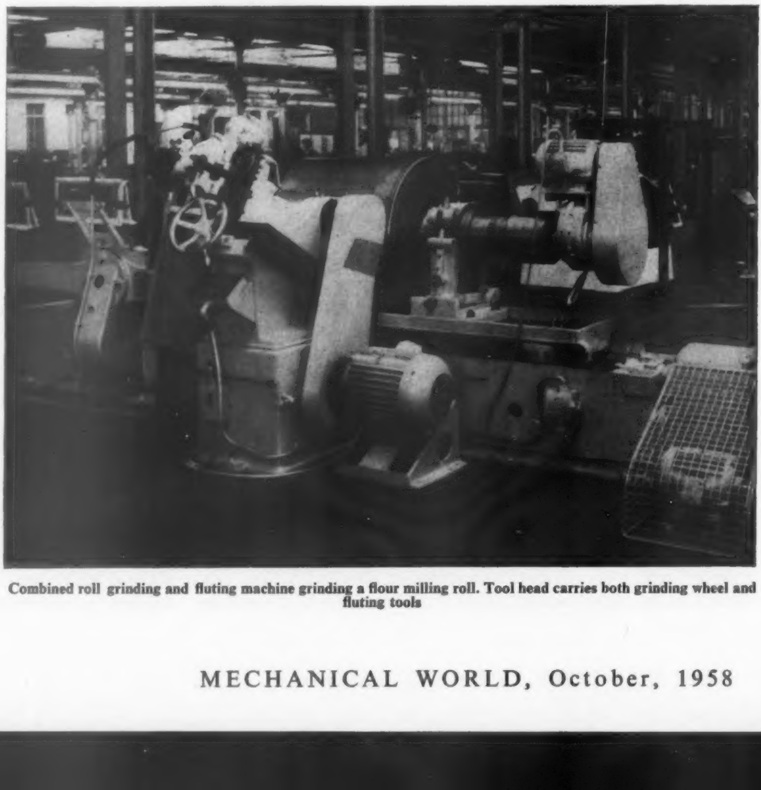
Spacing of the flutes is effected on the return stroke of the table by a pendulum lever being automatically lifted by a steel slide. and a pawl engaging a ratchet wheel. The ratchet movement transmitted to the chuck by bevel gears and a worm and worm wheel, gives a positive feed to the roll. An adjusting screw allows fine adjustments to be made to the flute spacing. Twisting the roll for spiral fluting is accomplished by a block attached to the bottom of the vertical worm casing. The block slides in machine cut slides of a canting sine bar which as the table moves backwards and forwards, moves the casing up or down, and results in the worm turning the worm wheel and chuck.

A deep stiffening flange round the outside edge of the table of the machine serves as a trough for the grinding lubricant. Two adjustable stands fitted to the table T-slots support the roll during machining. Each is robustly constructed and fitted with self-aligning bearing V-blocks to suit any normal diameter of roll spindle. Adjusting screws are fitted to the stands so that roll spindles can be aligned with the chuck. The drive to the table is by a large diameter square threaded screw, turning in a long gunmetal nut fixed to the underside of the table, the thrust being taken on ball bearing thrust washers. Lubrication to the nut is from an oil trough running the full length of the movement. The table travels on a substantial cast iron bed at the maker's recommended speed for fluting of 18 fpm which enables full use to be made of carbide cutting tools. The bed slideways, an inverted V-slide and a flat slide, are hand scraped to a high degree of accuracy. Lubrication is by oil wells cast into the bed and kept at a constant level by oil fillers with level indicators.

An electric switching mechanism, which can be operated either manually or by stops on the table side, controls the 2 hp reversing motor which drives the two-speed gearbox (one speed for fluting and one for grinding). The gearbox is securely mounted at the bed end, and is directly connected to the table screw.

An electric pump, supply and settling tanks provide an ample supply of grinding lubricant for free cutting. The two tanks and the pump are situated at the rear of the machine, the pump being connected by flexible hose to the grinding wheel nozzle which is easily removed when changing from grinding to fluting.

A stop-start push-button station controlling all motors is mounted on the base of the headstock and the free-standing starter panel can be placed in any convenient position.



Combined roll grinding and fluting machine grinding a flour milling roll. Tool head carries both grinding wheel and fluting tools

Standardized Design Simplifies Turbine Modifications

By introducing a simple and reliable basic design for a new range of small, high speed, geared steam turbines, rated from 200 to 1000 hp, J. P. Hall & Sons Limited, Peterborough, Northants, are able to modify any machine to suit particular working conditions with the minimum of alterations. For instance new nozzles and throttle valve seats can be supplied to convert a turbine from

steam to exhaust steam working and the whole alteration can be carried out in a very short space of time.

The basic turbine is a velocity compounded impulse type, mounted on a rigid fabricated combined frame and gearbox. Standardized

The J. P. Hall standard turbine

steel backed white metal journal bearings are used for the rotor and pinion shaft, and gear shaft. These can be removed without lifting out the shaft, and replacements can be inserted without the need for any scraping or hand fitting. Hydraulic constant speed governing system with manual speed variation control, hand trip control at the turbine, forced lubrication with oil circulation indicators, full flow oil filter, oil cooler, overspeed trip device, relief valve, tachometer, pressure gauges, etc., form part of the standard equipment.

High-duty 250 ton Press

The massive framing of this 250 ton I.D. 8S press built by Cowlishaw, Walker and Company Limited, Biddulph, Stoke-on-Trent is fabricated from stress relieved steel plate.

Their well-proved design of electro-pneumatic clutch-brake unit which incorporates electrical control with low voltage monitoring circuits provides a high standard of operational safety. The complete gearing and transmission are housed in the crown member and the gears are completely cased in easily removable covers.

A Metro-Vickers 30 hp 1350 rpm slip ring induction type motor powers the press at 25 strokes/min, the length of stroke being 8 in. The slide adjustment is powered by a Crompton Parkinson 3 hp, 1430 rpm, squirrel cage type motor with integral gear reduction giving final speed of 28 rpm.

The electrical control gear comprises a floor mounted main panel centralizing the contactors for the main motor, slide motor and clutch safety control and a master operating station mounted on the press upright.

Elevating Gravel with Corrugated Belting

The problem of elevating bulk material such as coal, oxide, ballast, etc., at steep angles without the need for cleats or flare-plates and eliminating costly troughed idlers has been tackled by C. H. Johnson (Machinery) Limited, Adswood Road, Stockport, Cheshire, by their introduction of Corruband flanged conveyor belting. This material incorporates corrugated flanges 3 in. deep and is so designed that belts up to 4-ply can be employed on drums as small as 7½ in. dia. Using flat idlers spaced at 4 ft for materials up to 50 lb cu ft and 3 ft 6 in. for materials up to 130 lb cu ft. a 24 in. belt running at 200 fpm provides capacity of 190 ton/hr. Where troughed idlers already exist Corruband belting can be successfully employed with greatly increased capacity. In our illustra-

Cowlishaw, Walker 250 ton model I.D. 8S press

A Johnson portable conveyor fitted with Corruband flanged belting

tion the conveyor is handling ¾ in. round natural gravel at 27° inclination.

Safety Shield for Exposed Conductors

A new type of fully-insulated conductor, designed to prevent the possibility of shocks through accidental physical contact, has been introduced by British MonoRail Limited, Wren Works, Chadderton, Lancs, for use on all types of overhead handling systems normally using exposed conductor bar electrification. The conductor or bus-bar in straight or curved length of channel section, ¾ in. wide ⅜ in. deep, and ⅛ in. thick is made of corrosion-resistant electro-galvanized steel enclosed in an extruded red P.V.C. sleeve of special design. The shielding is claimed to be fool-proof in use—even a man's little finger cannot be inserted to make contact —and the efficient functioning of the sliding shoe connector is not impaired.

A number of accessories have also been introduced, including P.V.C. safety covers, with provision for power feed, which clip over splices in the conductor bars; neoprene caps which fit over the shielding to protect the ends of a system; and insulating sections for use where conductor bars must be isolated.

The system, which is known as Kant-Shock, eliminates all risk of accidents so that many overhead handling systems now operating on 50 V can change over with safety to higher working currents, with obvious economies.

British MonoRail Limited also offer the Kant-Shock conductor for use with other electrified systems using the standard-sized channel section.

books

Thomas Telford. By L. T. C. Rolt. London, 1958; Longmans, Green & Company Limited. Price 25/- net (by post 26/1). 211 pp. $5\frac{3}{4}\times 8\frac{3}{4}$ in.

Nineteen fifty-seven marked the bi-centenary of the birth of Thomas Telford, a man who was undoubtedly one of the greatest engineers this country has ever known. Many of his great civil engineering works are faithfully serving us today—fitting memorials to the man's great technical ability and his mastery of materials. The pattern and progression of his life is one which commends itself to the industrial historian and it is gratifying to find that the work has been undertaken by Mr. Rolt who is surely no stranger to the subject—his recent work "Isambard Kingdom Brunel" was obviously a labour of love, and in "Thomas Telford" we have another.

Once again Mr. Rolt has set out not only to give an illuminating picture of the background to the problems which confronted Telford, but he has endeavoured as far as possible to shed some light on the character of the man himself and his loyal associates.

From humble origins Telford, apprenticed to a Langholm mason soon became an accomplished craftsman. Seeking fortune in London, his workmanship soon attracted the attention of influential men of his day and resulted in his first step to fame, his appointment as Surveyor of Public Works in Shropshire. His work in the county included amongst no less than 40 road bridges, the second iron bridge in the world, of 130 ft span at Buildwas in 1796. But already Telford was engaged on matters of far greater moment which were to carry him forward not as an architect, but as an engineer. In 1793 he became "General agent" to the Ellesmere Canal Company, a bold project to link the Mersey, Dee and the Severn and to tap the rich coal and iron workings of Ruabon. Part of the route over the difficult terrain of the Welsh Marches included the crossing of the Dee and Ceiriog valleys, but he solved the problem by carrying the canal in a cast iron trough upon stone piers 127 ft above the Dee. This magnificent aqueduct at Pont-y-Cysylte is Telford's canal masterpiece—a fact readily acknowledged by all who pass over it.

Although so actively engaged on the Welsh canals he organized a vast road construction programme in the Highlands of Scotland which was not completed until 1824. Though lacking the spectacular bridgeworks which we associated with Telford, his work in the Highlands, in terms of sheer magnitude, involving as it did nearly 1000 miles of new roads, is judged to be his greatest achievement. His fame soon spread abroad and in 1808 he accepted a commission to survey the Gotha Canal in Sweden.

In 1815 Telford was again active in Wales, this time the mail coach route to Holyhead which involved crossing the Menai Straits. Much of the road work was completed by 1819 and the famous suspension bridges at Menai and Conway with respective spans of 550 and 327 ft were opened in 1826. Here surely were structures which manifest Telford's early ambition to combine art with science. His later years, for he was by now a man of 70, were by no means unmarked; they included the new Harecastle Tunnel, and the building of the last great canal link, the northern line of the Shropshire Union Canal, completed in 1835, six months after Telford's death.

The book includes four maps of the canal systems and many illustrations of Telford's works.

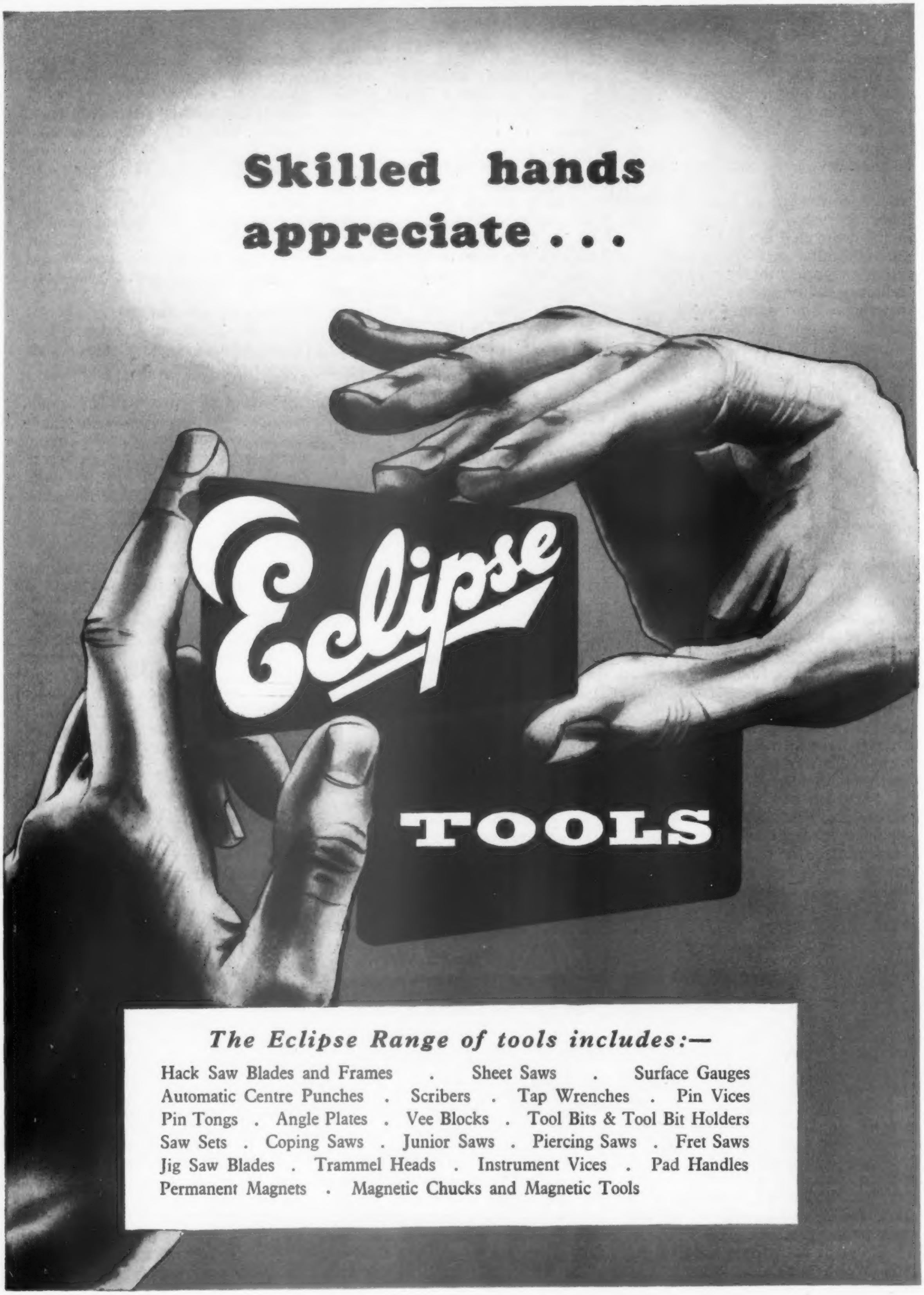
Electrical Maintenance and Repairs. By J. L. Watts. London, 1958; Cleaver-Hume Press Limited. 21/- net (by post 21/11). 324 pp. $4\frac{3}{4}\times 7\frac{1}{4}$ in.

If an engineer-in-charge analyses the possible causes of breakdown in the plant under his care he can do much to forestall trouble by careful planning and inspection. He is thus enabled also to provide the right kind of workshop and servicing equipment, devise suitable rigs for carrying out routine work expeditiously and can record everything thoroughly and systematically. Mr. Watts's book is an expert treatment of this category of work as it concerns electrical machinery. It is comprehensive and is the ideal text to have at hand in the plant engineer's office, whether for planning the maintenance scheme or for reference when guidance is required on how to tackle particular jobs. The routine inspection and maintenance of wiring installations is explained, earth-leakage protection and testing described, and routines given for inspection and servicing of both electrical plant and its control gear. Further chapters deal in detail with fault location and repairs on wiring installations and in plant, and with repairs to plant. A final chapter treats of the diagnosis of control gear troubles and appendices give information on the regulations relating to the use of electricity and on some revelant British standards.

Fine Boring and Turning. By W. Boneham. London, 1958; The Machinery Publishing Company Limited. 5/- net (by post 5/5). 67 pp. $5\frac{1}{2}\times 8\frac{1}{2}$ in.

Fine boring is one of the outstanding features of modern machining and is the means whereby many parts are produced to a high degree of accuracy. It employs the high speed, accurate spindle and the rigidly supported single-point tool, and—most important—a fine feed and a light cut, as a result of which the work can be lightly held and be free of distortion. The equipment is quite distinctive and there is a specialized technique, all of which is dealt with in this latest edition to the "Yellowback" series. Data are included on cutting tools, feeds and speeds and coolants, and there is useful information on setting-up and chucking for either stationary or rotating bar, and on some special operations.

Safe Practice.—Two booklets, the first of a new series on Industrial Safety, Health and Welfare subjects, have been published by H.M. Stationery Office, price 1/- each net, on behalf of the Ministry of Labour and National Service. The first is "Lifting and Carrying" and its advice is of almost universal application, not only throughout industry, but also to every man, woman and child in their daily lives. To supplement the booklet a brightly coloured wall sheet has been prepared which illustrates the most important points with a few words of explanation. Copies of this can be obtained through H.M. Stationery Office at 1/- net. The second booklet in the new series will deal with canteens and messrooms for small factories, and is in course of preparation. Number 3 in the series issued now, is "Safety Devices for Hand and and Foot Operated Presses". It is also well illustrated and describes the risks to be encountered when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The Eclipse Range of tools includes:—
Hack Saw Blades and Frames . Sheet Saws . Surface Gauges
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Saw Sets . Coping Saws . Junior Saws . Piercing Saws . Fret Saws
Jig Saw Blades . Trammel Heads . Instrument Vices . Pad Handles
Permanent Magnets . Magnetic Chucks and Magnetic Tools

operating these presses and deals in detail with the various types of guards and safety devices which can be fitted to prevent accidents.

B.E.A. Handbook.—The 1958 edition of the handbook issued by The British Engineers' Association, 32 Victoria Street, London SW1, price 21/-, presents classified lists of the members of the association, their manufactures, trade names and trade marks, the whole being additionally indexed in Portuguese, French, German and Spanish. The 660-page volume is substantially bound and good use is made of coloured papers to facilitate access to the different sections.

Design Report.—The 13th annual report of The Council of Industrial Design (The Design Centre, 28 Haymarket, London SW1, and the Scottish Committee of the Council, 46 West George Street, Glasgow C2; price 1/6), contains much of general interest and some interesting illustrations. In this issue there is only one purely mechanical example, a ship's telegraph re-designed by Mr. Richard Huws for Chadburns (Liverpool) Limited. It shows the edge-type visibility similar to that adopted in recent compass designs. The pedestal is neat and clean and more in conformity with the contours of the latest ships than was the traditional style.

New Log Tables.—A table of natural logarithms for arguments between five and ten to sixteen decimal places has been prepared by the U.S. National Bureau of Standards. As Series 53 it supersedes Mathematical Table 12. The practical computor in mathematics, physics, and engineering should find this table labour-saving in view of the fine interval, since four-figure arguments are often sufficient in practice; whenever the logarithm of a number given to more than four places is needed, linear interpolation is usually satisfactory since it gives approximately nine decimal place accuracy over the range of the table. Besides the practical use of the tables by engineers and other computors who have frequent use of natural logarithms and wish to obtain them with the least amount of effort and time, they are applicable and of great value in the preparation of many mathematical tables of other functions. The table is available from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C., U.S.A., price $5.00 by post.

Using Beta-ray Sources.—As industrial use of radioactive materials, X-rays, and particle accelerators increases, it is essential that adequate precautions be taken to protect the user and the public against excessive exposures to radiation. A handbook "Safe Design and Use of Industrial Beta-ray Sources" (National Bureau of Standards Handbook 66, 25 cents by post. Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.) has been composed to serve as a guide towards safe design, manufacture, installation, use, maintenance, and disposal of beta-ray sealed sources for industrial applications. It gives a generalized discussion of the many aspects of personnel protection in connexion with beta-ray sources, rather than a set of rigid safety rules for their manufacture and use. It contains a glossary of definitions, and chapters are included on radiation exposure, selection of radioactive materials, prototype testing instruction manuals, labels, working conditions, accidents entailing radiation hazards, and several chapters dealing with the handling of sources. There are two appendices: a listing of pertinent laws and regulations, and maximum permissible exposure limits.

Library Guide.—"What's available in the Technical Library", by the librarian of the Manchester Technical Library, offers students, research workers and "do-it-yourself" laymen an admirably informative survey of the library's resources other than its 80,000 books. Over 1,600 scientific and technical periodicals are currently received and, to enable readers to make full use of the files, Mr. Taylor describes the many periodical indexes, abstracting services and other bibliographical aids available. The library's collection of patents, standard specifications and atomic energy documents are also described. A well-chosen list of guides and bibliographies ends the pamphlet. Copies can be obtained, free of charge, from the Technical Librarian, Central Library, Manchester. (Telex 66-149 or Tel. No. Central 7401).

"Wear".—The Elsevier Publishing Company, of Amsterdam, are publishing a new international journal of this title devoted to the study of friction, lubrication and wear, and their control in industry. Papers so far published come from Australia, Japan, India, the Soviet Union, U.S.A., and Europe, and are printed in English, French or German.

"Safety".—A new magazine is produced by the Accident Prevention Committee of the British Iron and Steel Corporation. It appears every four months and is available to anyone in the iron and steel industry concerned with accident prevention—managers, foremen and safety committee members as well as accident prevention officers. Several aspects of safety are discussed and there are pages devoted to safety design in equipment.

New Standards

Electronic-valve Bases, Caps and Holders. (New sections for B.S. 448), Price 2/- each section.

B.S. 448, first introduced in its current loose leaf form in 1953, consisted of 30 sections. Four new sections, and one new replacement section, for B5E:1953 are now available. Their numbers and titles are:

Section	*Title*
B5E	Base (Issue 2)
B7G/F	Base, valve outline
B8D	Base, base pin position gauge valve outline
B8D/F	Base, valve ouline
B9A/F	Base, valve outline

Glossary of Terms used in Vibration and Shock Testing (B.S. 3015:1958). Price 5/-.

The glossary contains 72 definitions primarily of interest to those concerned with the study and testing of the behaviour of equipment when subjected to shock and vibration. A few of the terms have a specialized meaning in vibration and shock testing but most of them have a wide general use; the glossary does, however, clarify their meanings for use within the field it covers.

The 18-page publication concludes with mathematical appendices on line spectra, continuous spectra and spectra of experimentally determined quantities.

British Standards Institution, 2 Park Street London, W1.


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BUSINESS & PROFESSIONAL

Personal

Mr. N. S. Billington, M.Sc., M.I.H.V.E., head of the National College for Heating, Ventilating, Refrigeration and Fan Engineering since February 1950, resigned from this post on August 31 in order to take up the appointment of director of the Heating and Ventilating Research Council. He is succeeded at the College by **Dr. David R. Scott,** senior lecturer on the staff of the Royal College of Science and Technology, Glasgow.

Mr. R. J. Tristram has been appointed by the Moss Gear Company Limited as their technical representative to further the sales of automotive products.

Mr. W. Ernest Bradley and **Mr. Ronald Mountain** have been appointed to the Huddersfield and London sales offices of Brook Motors Limited respectively, as sales engineers.

Mr. P. A. Bridge has been appointed general manager of the Dunlop Hose Division.

F. H. Lloyd & Company Limited announce the following appointments to the board of directors: **Mr. W. R. Cooper,** assistant managing director of Lloyds (Burton) Limited; **Mr. W. H. Nicklin,** sales manager; **Mr. F. Clymer, A.M.I.Mech.E., A.M.I. Prod.E.,** foundry manager; **Mr. W. L. Beasley,** production manager. The following have been appointed directors of Lloyds (Burton) Limited: **Mr. M. C. Lloyd, M.B.E.,** assistant managing director of F. H. Lloyd & Company Limited; **Mr. F. Clymer,** foundry manager.

Mr. H. E. Cox, A.M.I.E.E., general manager BTH Rugby Works, has joined the board of directors of the British Thomson-Houston Company.

To mark his retirement in July last **Mr. E. R. Blane,** consultant with Mobil Technical Services Laboratory was presented with a motor garden mower and tankard by Mr. J. C. Gridley, chairman of Mobil Oil Company.

Mr. F. E. Wilson, well known in the machine tool field, has resigned his appointments within the C.V.A. Group, including directorships of E. H. Jones (Machine Tools) Ltd. and C.V.A. Small Tools Limited. Mr. Wilson is joining the board of B. Elliott (Machinery) Limited.

Miss Dorothy Smith, of the motor engineering department of Metropolitan-Vickers Electrical Company Limited, has been elected to full membership of the Institution of Electrical Engineers. Until this year, no woman has achieved this distinction since Mrs. Ayrton in 1899. Miss Smith was educated at the Manchester High School for Girls, having been awarded a Foundation and Lancashire County Scholarship. Upon matriculating, she joined Metropolitan-Vickers in 1916, and attended part-time studies at the Manchester College of Technology, gaining the College Associateship in Electrical Engineering.

E. H. Jones (Machine Tools) Limited, of Hove announce the following changes in personnel: **Mr. L. R. Newing** has been appointed outside sales manager for home sales; **Mr. H. M. Lebrecht, A.M.I.Mech.E.,** who has been manager of the special machinery sales division for some time, has been appointed inside sales manager; **Mr. G. Cranston** has been appointed area manager for Scotland and a new office and showroom will shortly be opened at Wilson Place, Nerston Industrial Estate, East Kilbride.

The British Transport Commission announce the appointment of **Mr. R. C. Bond,** at present chief mechanical engineer, British Railways Central Staff, to succeed **Mr. John Ratter** as technical adviser at Commission Headquarters on October 1, 1958, when Mr. Ratter becomes a full-time member of the Commission.

Mr. L. Holgate, previously in charge of planning and rate-fixing at the south works factory of Leyland Motors Limited, has been appointed chief time study engineer (H.Q.) of the company. Before joining the company in 1935, Mr. Holgate served his apprenticeship with Lang Bridge Limited of Accrington.

Following the reconstitution of Metal & Plastic Compacts Limited, motor cycle accessory manufacturers of Armoury Road, Birmingham, as the Motoplas Company Limited, the following board of directors is announced: **Mr. Edward Turner** (director of the BSA Company Limited and managing director of the BSA Automotive Division), **Mr. D. J. Hardwicke** (general manager, Motoplas), **Mr. R. J. Fearon** (general manager, BSA Motor Cycles Limited), **Mr. J. W. Binsted** (accountant, BSA Motor Cycles Limited). The secretary is **Mr. F. Ellinghouse.**

Mr. Ralph Gabriel, M.A., has been appointed managing director of Charles Churchill & Company Limited, the parent company of the Charles Churchill group.

British Insulated Callender's Construction Company Limited announces the following board and management changes, which took effect from August 1, 1958. **Mr. G. H. Walton,** joint general manager with Mr. O. J. Crompton since 1956, relinquishes his executive duties on reaching retirement age. He continues to be available for consultation and remains on the board of the company and also of British Insulated Callender's (Submarine Cables) Limited, Painter Brothers Limited, and Engineering Projects Limited. **Mr. O. J. Crompton, M.Eng., M.I.E.E.,** has been appointed general manager of the company. **Mr. G. A. Rendle, B.Sc., M.I.E.E.,** has been appointed deputy general manager and continues to act as manager of the Power Cable and Telecommunication Cable Contracts Departments, **Mr. E. T. Q. Davies** has been appointed director and continues to act as manager of the Overhead Line Contracts Department. The company also announces the retirement from the board of **Mr. F. B. Kitchin, M.I.E.(Aust.).** Mr. Kitchin also relinquished his directorship of British Insulated Callender's Cables (Australia) Pty. Limited. **Mr. O. W. Minshull, B.Sc., M.I.E.E.,** has been appointed general manager of the Power Cables Division.

Mr. P. W. Percy, F. Perkins Limited's resident representative in Central America and the Caribbean, will in future be based in the United States instead of Jamaica. His duties will then also include representing F. Perkins (Canada) Limited, the company's Canadian subsidiary, in the southern states of the U.S.A. Mr. Percy recently returned from Britain, where he has been on leave.

Mr. H. Morley, formerly deputy general works manager of Samuel Fox & Company Limited, a subsidiary of The United Steel Companies Limited, was appointed general works manager of the company on September 9, in succession to **Mr. J. D. Joy.** As already announced, Mr. Joy has been appointed director and general works manager of Appleby-Frodingham Steel Company with a view to becoming deputy general manager on January 1 next. **Mr. C. M. Slocombe,** former director and chief engineer of Samuel Fox, was appointed director of engineering on September 9, and is succeeded by the deputy chief engineer, **Mr. J. Hammond. Mr. H. J. Strong** has just joined the company to work with the chief engineer with a view to becoming works engineer on January 1.

Captain R. L. Jordan, formerly engineer manager of the Royal Naval dockyard at Chatham, has been appointed a director of Fawcett Preston & Company Limited, one

STANDARD MOTOR CO. LTD.
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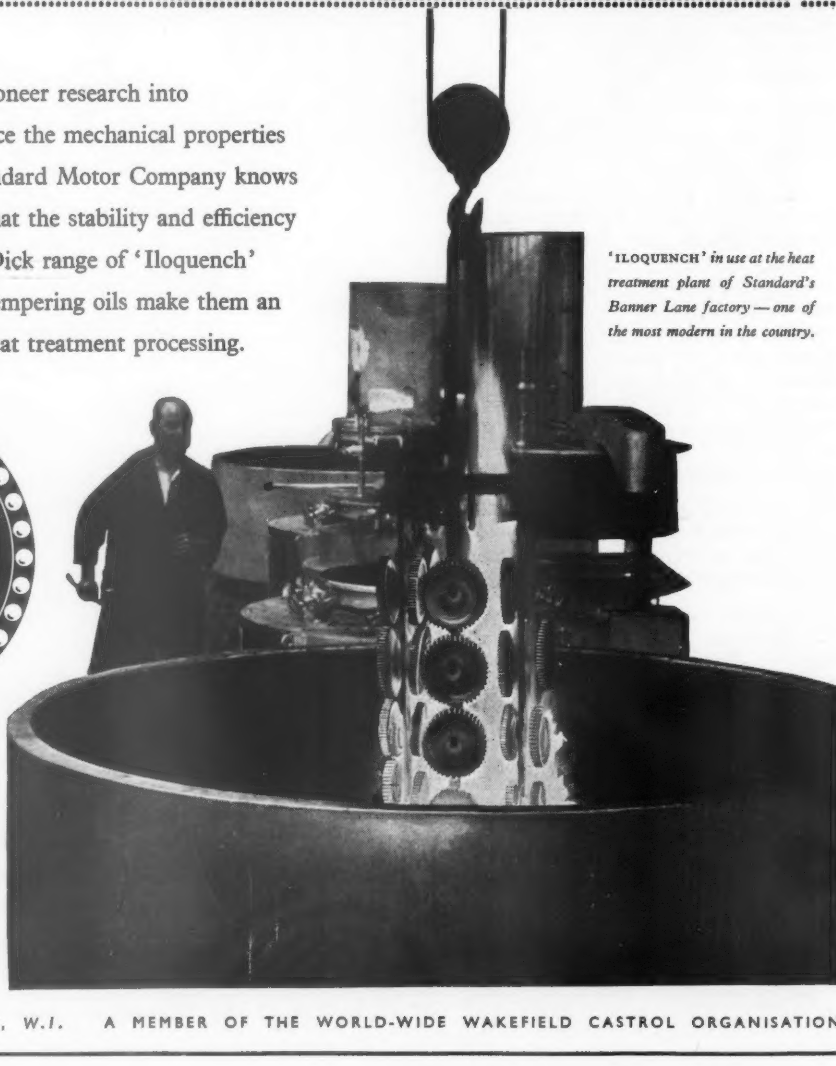
ILOQUENCH OILS

Wakefield-Dick pioneer research into oils used to enhance the mechanical properties of steels. The Standard Motor Company knows from experience that the stability and efficiency of the Wakefield-Dick range of 'Iloquench' Quenching and Tempering oils make them an essential part of heat treatment processing.



'ILOQUENCH' in use at the heat treatment plant of Standard's Banner Lane factory — one of the most modern in the country.

INDUSTRIAL WAKEFIELD-DICK LUBRICANTS

WAKEFIELD-DICK INDUSTRIAL OILS LIMITED

67 GROSVENOR STREET, LONDON, W.1. A MEMBER OF THE WORLD-WIDE WAKEFIELD CASTROL ORGANISATION

of the Metal Industries Group. **Mr. A. J. Taylor** has been appointed contracts manager of the company. The new general sales manager is **Mr. H. H. Saint** who will be responsible for all home sales. **Mr. E. P. Bridson,** formerly in charge of the company's London office, becomes export sales manager.

Mr. J. F. Stott has retired after 39 years service with Automatic Telephone and Electric Company, Liverpool. At a dinner given in his honour he was presented with a refrigerator and a gold watch each for his wife and himself.

THE NUCLEAR POWER PLANT COMPANY Limited, Booths Hall, Knutsford, Cheshire, announce the appointment of **Mr. R. D. Vaughan, B.Mech.E., A.M.I.Mech.E.,** to the board of directors. Mr. Vaughan has been chief engineer of the company for the last three and a half years.

STOCKDALE ENGINEERING LIMITED, Poynton, Cheshire, announce the appointment of **Mr. Ian MacLeod, M.A.S.M.E., A.M.I.P.E.,** as technical director.

Mr. George Campbell, B.Sc., A.R.C.S.T., F.R.I.C., A.M.I.Mech.E., has been appointed general manager of the Chemical and Metallurgical division of the Plessey Company Limited. He was previously technical manager and deputy general manager of the company's Towcester plant.

Obituary

WE regret to record the death of **Mr. Walter N. Mann, A.M.I.H. & V.E., M.Amer.H. & V.E.,** a former director of Panelec (Great Britain) Limited, electro-thermal engineers. Mr. Mann served on the board until his retirement in March last, and acted as heating consultant to the company. He was a Liveryman of the Worshipful Company of Plumbers.

WE regret to record the death in Glasgow on August 12 of **Mr. Albert W. Davies,** late works director of Mavor and Coulson Limited. He joined the company in 1896. Mr. Davies retired from the board of directors in 1948 but his services were retained in an advisory capacity.

WE regret to record the death, whilst on holiday in the Wirral, Cheshire, of **Mr. Norman G. Widger,** publicity manager of G. & J. Weir, Limited, the Glasgow engineers. A native of Plymouth, Mr. Widger joined Weir's in 1940 following a varied career which included service at sea as a radio engineer and some years with advertising agents and studios in London.

Addresses

THE London office of Holman Brothers Limited, 44 Brook Street, W1, has also now become the London office of Climax Rock Drill & Engineering Limited, who have moved their premises from 4 Broad Street Place, E.C.2. The London manager for the Holman Group is Mr. W. B. Tozer, who is well known in the mining, civil engineering and petroleum industries. The Holman office, formerly at Elmbank Street, Glasgow, and the Climax office, at Cathedral Street, Glasgow, will, in future, have their common home at new premises which have been purchased at 20/26 Ashton Lane, Glasgow, W2. Managing the Scottish Office will be Mr. Tom Jones and the premises are being adapted to provide first class sales, stores and servicing facilities.

FROM August last the plastics division of Metal & Plastic Compacts Limited, motor cycle accessory manufacturers of Armoury Road, Birmingham 11, is trading as the Motoplas Company Limited; and the metals division of M.P.C., of Montgomery Street, Birmingham 11, is now known as Metal & Plastic Components Limited.

BUCK & HICKMAN LIMITED, London, have opened a branch in Bristol at 12, 13 and 14, Victoria Road, St. Philips, Bristol, 2. (Telephone Bristol 79331) where stocks of all types of engineers tools will be carried. Mr. R. Brookes has been transferred from Alperton and appointed manager of the new Branch.

THE headquarters of the BTH Electronics Group have now been transferred from Rugby to Leicester and communications should be addressed to New Parks Boulevard, Leicester (Telephone: Glenfield 531) where the new offices and Industrial Electronics Factory are situated. The following addresses are unchanged:—Military Electronics and Radar—Blackbird Road, Leicester. Valves and Semi-conductors—Carholme Road, Lincoln.

THE address of the Diesel Engineers and Users Association is now 18, London Street, London, EC3. (Telephone number, Royal 2393.)

THE executive offices of Kelvin & Hughes Limited have been transfered from Caxton Street, SW1 to new premises at Empire Way, Wembley, Middlesex. (Telephone Wembley 8888. Telegrams: Kelhue, Wembley.)

CAWKWELL RESEARCH & ELECTRONICS LIMITED have moved to new premises at Scotts Road, Southall, Middlesex. The telephone numbers remain as before Southall 3702 and 5881. Export enquiries should be sent to M. Falk and Company Limited, Emefco House, Reigate, Surrey.

DIAGRIT DIAMOND TOOLS LIMITED have now moved to their new factory at Station Road, Staplehurst, Tonbridge, Kent. Telephone: Staplehurst 479.

THE HOTPOINT ELECTRIC APPLIANCE COMPANY LIMITED has changed its name to A.E.I.–Hotpoint Limited. The new title reflects Hotpoint's membership of the A.E.I. group of companies.

THE London sales office of Brook Motors Limited, formerly at Westminster, has been transferred to larger and more convenient offices at 1-2 Finsbury Square, E.C.2. New telephone numbers, METropolitan 9401/7, have been allocated, but the Telex details remain as before Brookmot Phone London Telex 2-2142. The offices are in a new building not far from the Moorgate Underground Station.

I.C.W.A. Prize Winners

THE Institute of Cost and Works Accountants has made the following awards: Mr. Ralph David Haxby, works deputy chief accountant with Babcock and Wilcox Limited, Renfrew, has been awarded the Lewton Coronation Prize in management accountancy in the Fellowship examination, and the S. Laurence Gill prize for the first place in the final examination has been awarded to Mr. John Herbert Miles, chief factory accountant with The Ministry of Supply R.O.F., Crewe.

Electric Tools and Safety

FREE copies of a safety poster entitled "Electric tools can't be careless—but you can", can be obtained by readers from Wolf Electric Tools, Limited, Pioneer Works, Hangar Lane, W.5, or from the British Safety Council. The poster is obtainable in double-crown size or in a small notice board size.

Rockwell Merger

BY agreement Coventry Gauge & Tool Company Limited are to acquire the whole share capital of Rockwell Engineers Limited. On completion of the merger Mr. C. E. Rockwell and Mr. John Middleton will join the board of Coventry Gauge and Tool Company Limited. The Rockwell Machine Tool Company Limited will continue to operate under its own name.

Thompson Grinding Machines

THE Coventry Gauge & Tool Company Limited have negotiated a license to manufacture in the United Kingdom the range of grinding machines made by The Thompson Grinder Company of Springfield, Ohio, U.S.A., the sole agency for which in the United Kingdom will be held by the Rockwell Machine Tool Company Limited.


Your metal requirements
CAN BE SATISFIED BY
NETTLEFOLD & MOSER
WIDE RANGE, LARGE STOCKS AND A
SPEEDY DELIVERY SERVICE
Our Stock range covers:
'Mills' Bright Steel: rounds, squares hexagons, angles, flats.
'Mills' Ledloy Bright Freecutting to Spec. EN.I.A: rounds, squares, hexagons.
'Mills' Bright Steel to EN Specifications.
Aluminium Sheets.
Brass Bars & Flats.
Black Mild Steel: rounds, squares, flats, strip, hoops, angles, channels, tees.
Crown Wrought Iron: rounds, flats, squares, half rounds.
Sheets: Black: Cold Reduced General Purpose and Oiled, Hot Rolled Strip Mill, C.R.C.A.P.F.
Galvanised: "Galvatite", "Speltafast", C.R.C.A.P.F., Corrugated.
Steel Plates.
Nettlefold & Moser Limited are main stockholding agents for Exors of James Mills Limited (Bright Steels) and United Wire Works (Birmingham) Limited (Brass Bars & Flats).

Contracts and Work in Progress

E.M.I. ELECTRONICS LIMITED, Hayes, Middlesex.—Orders from Italy and Holland for electronic machine tool control systems.

HEENAN & FROUDE LIMITED, Worcester.—Contract placed by BBC for a temporary microwave radio link to serve the new transmitting station in the Orkneys. The supply of three sets of engine test plant to Iranian Oil Services Limited for installation at the company's central workshops at Ahwaz. Further recent export orders include one from Ormec, S.A., Italy, for two special Mark V Heenan dynamatic dynamometers.

AERO MAINTENANCE EQUIPMENT LIMITED, London (member of the Arusha group of companies and sole concessionaires in U.K.).—Orders totalling £70,000 for Bennes-Marrel multi-bucket hydraulic lifting and haulage units, including one for the supply of a fleet to The Steel Company of Wales. Units also being supplied to Trinoil of Trinidad, Bridgwaters of Epsom, and Metal Agencies, Bristol.

NORTH BRITISH LOCOMOTIVE COMPANY Limited, Glasgow.—Contract from British Transport Commission for the supply of 33 diesel-electric locomotives (Type 4) and 20 type 2, delivery to begin in 1959.

ENGLISH ELECTRIC COMPANY LIMITED, Phoenix Works, Bradford.—30 diesel-electric locomotives of 2000 hp (Type 4).

BRITISH THOMSON-HOUSTON COMPANY Limited, Rugby.—Contract from London Transport for 503 traction control equipments.

BABCOCK WILCOX LIMITED.—Contract valued at £5M has been awarded by the State Electricity Commission of Victoria, Australia to Babcock Wilcox Limited, Australia, for boiler plant for the Yallourn E Power Station. More than one fifth of the work will be executed at the U.K. headquarters of the company.

METROPOLITAN VICKERS ELECTRICAL Company Limited, Trafford Park.—This company will make a large share of the Turbo-generator plant and electrical equipment for the Yallourn Power Station ordered by the State Electricity Commission of Victoria, from Australian Electrical Industries Pty Limited.

WILD-BARFIELD ELECTRONIC FURNACES Limited, Watford, Herts.—Large gas carburizing furnace for the Hunslet Engine Company Limited. The furnace which is 48 in. dia by 54 in. deep, will operate on the Carbodrip drip feed system. Two arc melting vacuum furnaces have been ordered by the Atomic Energy Authority Risley.

THE COMPOFLEX COMPANY LIMITED, Haywards Heath, Sussex.—Repeat order for road tanker hoses from the Kuwait Oil Company Limited and orders for hoses from a large oil refinery in Sweden, the Netherlands and New Zealand.

WICKMAN LIMITED, Coventry.—Heenan CW10 chain welding machine for Daihan Anchor Chain Manufacturing Company of Korea.

RANSOMES & RAPIER LIMITED, Ipswich.—Order for six RapieR 4 standard mobile cranes from the Cunard Steamship Company Limited, Liverpool.

FERRANTI LIMITED, Hollinwood,—High-speed Mercury electronic digital computor for the Belgian Atomic Energy Authority. This type computor has already been ordered by six other atomic centres; Geneva, Paris, Oslo, Stockholm and the U.K. centres at Harwell and Risley.

'Matheys' Jig Boring Machines

THE sole selling rights for the "Matheys" range of jig boring machines for the U.K. and certain other territories have been acquired by A. A. Jones and Shipman Limited, of Narborough Road South, Leicester. The machines, which are of Belgian manufacture, have a high reputation for accuracy and performance whilst they are moderately priced. This selling arrangement is a reciprocal one, as "Matheys" have been sole selling agents in Belgium, Luxemburg and the Belgian Congo for a great number of years for all Jones-Shipman machine tools.

Du Pont Research Laboratory

AN elastomers research laboratory is to be constructed by Du Pont Company (United Kingdom) Limited at Hemel Hempstead, Hertfordshire. It will enable rubber manufacturers in the United Kingdom and on the Continent to take advantage of the latest advances in research, testing, and manufacturing processes, and will duplicate mill equipment and conditions found in the British rubber processing industry.

New French Valve Company

WITH the formation of a new company, Hindle-Hamer Francaise, S.A.R.L., the products formerly manufactured by Joshua Hindle & Sons Limited, Leeds, under licence from Hamer Valves Inc. of California, U.S.A. will now be available manufactured in France. The head office of the new company will be at 6, Avenue Franklin-Roosevelt, Paris VIII^{e}.

New Project

THREE leading British engineering firms The Power-Gas Corporation Limited, John Thompson Limited, Humphreys & Glasgow Limited have formed a new company under the title "Nuclear Chemical Plant Limited". The new company will be concerned with the design and engineering of process and treatment plant for the nuclear industry.

Brayshaw Development

Two new companies have been formed by Brayshaw Furnaces and Tools Limited, Manchester, 12 to deal respectively with work previously handled by their industrial furnaces and engineers' tools divisions. The new companies are Brayshaw Furnaces Limited and Brayshaw Tools Limited. The registered office will continue to be located at Belle Vue Works, Manchester. A branch office for Brayshaw Furnaces Limited has been opened at 84 Blonk Street, Sheffield 3. This year marks the Diamond Jubilee of the original company.

Birlec New Division

A SEPARATE division has been created by Birlec Limited to deal solely with orders for the company's standard furnaces, which hitherto have been built by their Heating Division. The new division will be known as the Standard Furnace Division and will be under the managership of Mr. John Penfold, previously furnace department manager of the Morgan Crucible Company.

Rocol Agencies

THE following Canadian concerns have been appointed Rocol agents: British Columbia, International Agencies and Machinery Company Limited, 2315 Cambie Street, Vancouver, B.C. All Canada except British Columbia: W. R. Watkins Company Limited, 41 Kipling Avenue South, Toronto 18. These appointments result from a tour of Canada made recently by Mr. J. G. Gershon, sales director of Rocol Limited of Swillington, near Leeds, manufacturers of molybdenized and other lubricants.

Maxam—Now a Company Name

TEN years after the creation of a Maxam division by Climax Rock Drill & Engineering Limited, it is announced by the Holman Group, of which Climax is a member, that a new company, Maxam Power Limited, has been formed which is to be based at Camborne, Cornwall.

E.C.G.D. Upgraded

IN view of the expansion of the work of the Export Credits Guarantee Department, the Government have decided to upgrade the status of the department. Mr. L. J. Menzies has been seconded by the Bank of England for a period of 2-3 years to the post of Secretary of the department.

RAWLPLUG

VIBROTO

REGISTERED TRADE MARK

DRILLING MACHINE

3 in 1 Power Tool

1 A high efficiency power tool which allows a selection of one or two vibrationary actions. An outstanding speed of penetration is achieved using 'Vibroto' hard tipped drills.

2 A rotary power tool (without vibrations) using Durium tipped Drills.

3 A general purpose power tool for use with Standard Twist Drills.

DEMONSTRATIONS

The ***PERFORMANCE*** has to be ***SEEN*** to be ***BELIEVED!***

Demonstrations of the Rawlplug 'VIBROTO' Drilling Machine can be carried out by Rawlplug Technical Representatives in any part of the British Isles. If you are interested please write to the Rawlplug Technical Service Department on your business heading and arrangements will be made to suit your convenience, or write for technical literature.

By far the fastest method of boring holes in masonry materials

E603

THE RAWLPLUG COMPANY LIMITED, CROMWELL ROAD, LONDON, S.W.7

Trade Literature

Installation and Care of Electric Motors and Control Gear

A revised and enlarged version of a booklet first published by The British Thomson-Houston Company Limited, Rugby in 1953 has now been produced.

The introduction deals with the choice of an electric motor, the following chapters consisting of notes on installation, care and maintenance, diagnosis of faults, and causes and effects of unsatisfactory performance. A chapter devoted to control gear includes hints on the installation and maintenance of various types of equipment. The booklet which is well illustrated with diagrams and photographs stresses the importance of efficient and regular maintenance in order to reduce the risk of serious breakdown. The company will be pleased to send a copy of their publication to anyone professionally interested.

Electrical Equipment for the Oil and Chemical Industries

A handsomely bound volume entitled "Electrical Motors and Associated Equipment for the Oil and Chemical Industries", has recently been published by Metropolitan-Vickers Electrical Company Limited, Trafford Park, Manchester 17.

Engineering personnel in the oil and chemical industries are invited to apply for this publication. For convenience the book is divided into three sections, viz., Flameproof Equipment, General Information and Non-Flameproof Equipment and besides covering the main types of equipment much detailed information is included to facilitate selection and the provision of special requirements such as protection against fire hazards. Reference is also made to the requirements of British and American inspection and standardization authorities.

The Collis Truck, Pallet Type

A recent addition to the range of well known Collis trucks is the Collis truck, pallet type, described in List 308 issued by the makers, J. Collis & Sons Limited, Regent Square, Gray's Inn Road, London WC1. All wheels are fitted with twin ball bearings and in addition rollers assist entry into and withdrawal of the forks from the pallet. The truck capacity is 1 ton.

Also available on request are the Motaveyor List No. 307 which describes and illustrates interesting features of this motorized belt conveyor in both sectional and unit designs, and Conveyor List No. 306 giving brief and concise descriptions of the range of Collis Conveyors.

Multi-slide Machines for Intricate Stampings

A recent publication from Rockwell Machine Tool Company Limited, Edgware Road, London NW2, describes the British-built 28 and 35 U.S. Multi-Slide machines. These machines are designed for producing intricate stampings in one operation. Material saving is a strong point of the design, no extra material width is generally required either for side-cropping or piloting and the parent material width is usually equal to the width of the developed blank only. Numerous attachments including cut-off slides. and tapping heads are available.

Overhead Handling Equipment

The first two sections of a comprehensive catalogue giving full details of their complete range of automatic transfer and overhead handling equipment and accessories has been published by British MonoRail Limited, Wakefield Road, Brighouse, Yorks.

The first of the two sections now available describes every individual piece of equipment—tracks and suspension equipment, girder rails, trolleys and switches, etc.—supported by illustrations, specifications and dimensioned drawings. The second section consists of reports, photographs and diagrammatic layouts of actual MonoRail installations.

Heat Treatment Furnaces

A representative selection of heat treatment and special purpose furnaces are displayed by Royce Electric Furnaces Limited, Sir Richard's Bridge, Walton-on-Thames, Surrey, in the form of an illustrated catalogue. Amongst the types shown are bell-types suitable for temperatures up to 1150° C, pit types up to 1350° F with silicon resistors, box types up to 1400° C, and carbon tube furnaces for temperatures up to 2500° C. Other types include continuous and hump-back conveyor furnaces, and muffle furnaces.

Diamond Tools

A loose-leaf catalogue listing a comprehensive range of diamond wheels and hones has been produced by Diagrit Diamond Tools Limited, Pattenden Lane, Marden, Kent. Diagrit hones are suitable for use on all types of materials including hard and soft steels, cast iron, chromium plate, nitralloy materials, tungsten carbide ceramics, etc. Wheels listed are suitable for cemented carbides, machine lappng, internal grinders and chip grooving for carbides.

Pneumatic Equipment

Publication No. 3, "Pneumatic Equipment" issued by Westinghouse Brake & Signal Company Limited, 82 York Way, Kings Cross, London N1, contains a representative range of their products. Items include control devices, positioning and auxiliary devices, compressors and supply fittings. The index provides a detailed list of all Westinghouse pamphlets which are available for further details of products if required.

Portable Ammeters and Voltmeters

Strong portable instruments in die-cast cases and oiled teak frames of the style adopted by The Record Electrical Company Limited, Broadheath, Altrincham, Ches., require no carrying handle as they are shaped to provide a natural grip for the fingers. As described in an illustrated leaflet the instrument range is as follows; moving coil type 250 microamp to 50 amp and from 60 millivolts to 600 volts; moving iron type from 10 milliamp to 50 amp and from 10 volts up to 600 volts self-contained.

Horizontal Balanced-opposed Compressors

A new catalogue describing their recently introduced Class F.E. range of horizontal double-acting balanced-opposed compressors, has been produced by The Consolidated Pneumatic Tool Company of 232 Dawes Road, London, SW6. It gives full details of design, application and operation, together with detailed specifications of various units ranging in capacity up to 500 cfm and pressures up to 3000 psi.

Terminal Blocks

A leaflet giving particulars and prices of Kabi 2.B.A. unit terminal block U.30—30 amp and Kabi O.B.A. unit terminal block U.60—60 amp has been issued by Kabi Precision Components (Barnet) Limited, 13 Byng Road, Barnet, Herts.

The 30 amp block is moulded in 4-way units, the 60 amp in single units, which can be built up as multi-way banks on m.s. bearers. Both blocks are available with or without covers.

Facts About Albright & Wilson

This is the title of a pleasantly produced booklet issued by Albright & Wilson Limited, 1 Knightsbridge Green, London SW1, the well known British chemical group. The booklet, illustrated by numerous halftones, describes very briefly the structure of the Albright & Wilson Group of Companies and the activities of some of the larger manufacturing companies within the Group.

Dial Gauge Catalogue

The Baty catalogue of dial gauges, now in its ninth edition has just been issued by J. E. Baty & Company Limited, Burgess Hill, Sussex. It contains details of the latest dial indicators, small bore gauges, dial micrometers, depth and recess gauges, optical projectors and numerous accessories.

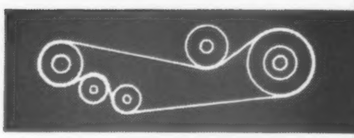
Titanium Welding

Methods of fusion welding, resistance and flash welding Hylite titanium alloys are fully described in a Jessop information sheet No. M.783 issued by William Jessop & Sons Limited, Sheffield.

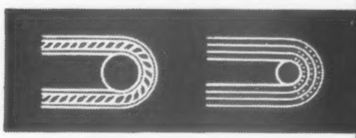
3T CORD

Exclusive Goodyear development means stronger, thinner, more flexible transmission belting.

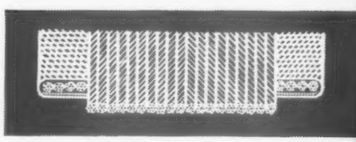
No splice failure
In construction the cord is wound continuously around two pulleys to produce a truly endless belt.



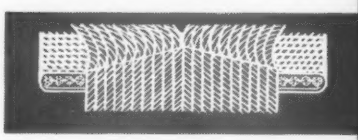
No ply separation
The single layer of load carrying cords round the pulley together, preventing internal stress.



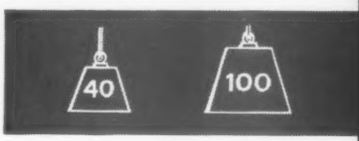
Less lateral movement
To neutralize lateral movement half the cords are twisted to the right and half to the left.



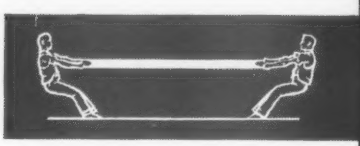
Elastic envelope
Designed to provide high friction surface to grip the pulley and transfer load to the cords.



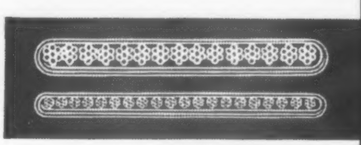
Stronger 3T Cord
2½ times stronger than cotton and each filament of fibre is continuous, like the cord itself.



Less stretch
Triple Tempering removes surplus stretch but only to a degree where it does not hinder the flexibility of the fibre.



Thinner belt
3-T Cord belt is 25% thinner than belts of equal horse-power rating.



THE amazing new Goodyear 3-T cord process – successfully applied to motor car and commercial vehicle tyres – is also making transmission belts work harder, last longer and cost less for a given horsepower rating.

The synthetic cords are 'triple-tempered' – passed through a process at a controlled Tension and Temperature for a specific Time – to give them maximum strength and flexibility, minimum stretch. The result is that you can use a thinner belt – get improved flex life, longer wear, more efficient transmission and reduced maintenance.

There's a Goodyear 'job-designed' transmission belt for every drive . . . every duty.

NEW HD ENDLESS CORD BELT

The synthetic 3-T cords are 2½ *times stronger* than cotton. This means longer service at lower cost on any drive. The special design of the belt eliminates splice failure and ply separation. HD Endless Cord costs no more, yet you get much higher horsepower ratings, better service all round.

GOODYEAR

INDUSTRIAL RUBBER PRODUCTS

Transmission Belting
Conveyor Belting · Hose
V-Belts · Industrial Fenders

THE GOODYEAR TYRE & RUBBER COMPANY (GREAT BRITAIN) LIMITED, WOLVERHAMPTON

Chains for Contractors' Plant

There are few instances where the demands made on plant and machinery are as rigorous as those experienced in road and public works undertakings. The part played by Renold Chain drives in these machines is well portrayed in a colour folder published by Renold Chains Limited, Renold House, Wythenshawe, Manchester which shows power drives for all types of diggers, mixers, crushers, loaders and graders.

Low Temperature Silver Brazing

A new series of technical data sheets on the subject of low temperature silver brazing are being issued by Johnson, Matthey & Co. Limited.

These data sheets will provide detailed comprehensive information on all aspects of silver brazing and will include the solution of specific silver brazing problems.

The new data sheets are available on application to the Publicity Department at the company's head office at 73/83 Hatton Garden, London EC1

High Speed and Alloy Tool Steels

A booklet summarizing the standard brands of tool steels manufactured by Sanderson Brothers and Newbould Limited, Attercliffe Steelworks, Newhall Road, Sheffield has been published. They include high speed steels, die steels for hot and cold working and water hardening carbon tool steels. Full heat treatment data is included for each type.

New Factories

Bishop Auckland. J. and G. Turnbull, West Auckland. Plans for light industrial development at Union Street have been prepared by Smith Gore and Co., surveyors, Bondgate.

Elliott Motor Supplies Limited. Workshops and showrooms. Architects, Cackett, Burns, Dick and McKellar, 21 Ellison Place, Newcastle upon Tyne.

Cleator. Cumberland Paper Company Limited. Factory additions. Architects, Ward & Partners, 29 Chesham Place, Belgrave Square, London SW1. No contracts let.

Darlington. Richardson and Company, heating engineers. Office additions in Neaham Road. N. H. Godsmark, Tubwell Row, architect.

Gateshead. Gateshead and District Omnibus Company Limited. Plans are being prepared for a garage extension in Sunderland Road. Architect, R. C. Cowmeadow, Churcham, Gloucester.

Newcastle upon Tyne. G. S. Akinhead and Co. Limited, plumbers and heating contractors, are to extend their premises in Railway Street. The architect is C. Solomon, 30 St. Mary's Place, Newcastle upon Tyne.

Spennymoor. E. and R. Proud Limited, haulage contractors, Tudhoe Lane, Tudhoe are to erect garage (2,800 sq ft) at Spennymoor, and have prepared own plans.

Stockton-on-Tees. F. F. Robinson, Limited. Offices and garage in Yarm Road. Plans prepared by R. Cowan, 20 Finkle Street.

The British Transport Commission, York, are to erect railway carriage and wagon depot near Newport Bridge and have prepared their own plans.

Sunderland. J. L. Thompson and Sons, Limited. Construction of a shipbuilding berth able to accommodate tankers up to 65,000 tons d.w. Contract placed with Brims & Co. Limited, City Road, Newcastle upon Tyne. Consulting engineers, Tripp and Partners, 210 Westgate Road, Newcastle upon Tyne.

Wallsend. National Coal Board. Plans have been approved for further development and reconstruction work to surface buildings at Rising Sun Colliery. Consulting engineers, Posford Pavry and Co., Abbey House, Westminster, London SW1.

West Hartlepool. William Gray and Co. Limited, shipbuilders, are to construct a platers' shed of 21,000 sq ft at Graythorpe and plans have been approved. The architects are Mortimer and Partners, High Street, Northallerton.

Robert Robinson Limited. Showrooms etc. in South Road and Pensance Street. Architect, C. L. Heslop, 7 Upper Church Street.

Whitehaven. The West Cumberland Industrial Development Company Limited, 30 Roper Street, are to extend two factories and work will be put in hand during the coming year.

West Cumberland Silk Mills Limited. Factory additions. Architects, Ward and Partners.

Airdrie. Maitlands (Iron founders) Limited, Gartlea Road are to make extensions to their factory.

Ashton-under-Lyne. Richard Whiffen Limited, Wellington Road are to erect a new factory.

Barking. Chemical Supply Company Limited. Extensions are to be made to the factory in Linsdell Road.

Birmingham. A. J. Gilbert (Birmingham) Limited, 78 Buckingham Street are to make extensions to their works.

Mint (Birmingham) Limited, Icknield Street. Works extensions.

Blackpool. L. & W. Theckston Limited, 1 Stanmore Avenue, South Shore. New factory and offices in Mitcham Road. Architects, Gorst, Crabtree & Denbigh, 7 Birley Street.

Bolton. Vactric (Manufacturing) Limited, Minnie Street. Extensions are to be made to the works.

John Twisse & Co. Limited. To make extensions to their Moss Dye Works.

Bridgnorth. Rexin Precast (Midlands) Limited, Knowle Sands. To erect a new concrete products factory in Stourbridge Road.

Brighouse. Tufted Carpets Limited. Extensions are to be made to Brookfoot Mills.

Cheltenham. Gibbard & Co. Limited are erect a new factory at Tewkesbury Road.

Chesterfield. Robinson & Sons, Limited. To extend Wheat Bridge mills.

Coatbridge. S. H. McKinnon & Co. Limited, Montrose Works, Carfin. The contract for the erection of a new factory at Shawhead has been let to the Kelvin Construction Company Limited, Lochburn Road, Glasgow NW.

Coventry. B.M.W. Engineering Company Limited, 92-100 Cox Street are seeking permission to erect a new factory at Cromwell Street and Bright Street.

Coventry Cees Limited, Spon Street are to erect a new works in Torrington Avenue.

Croydon. Bourdon Tools Limited, Union Road. Works extensions. Architects, H. Mackintosh & Partners, 33 High Street.

Freeman Morrison Limited, Parchmore Road, Thornton Heath. Factory extensions.

Edmonton. Ever Ready Company Limited, Extensions are to be made to the factory at Elsey's Estate, Angel Road.

Enfield. Enfield Tool Manufacturing Company Limited. A new factory is to be built in Alma Road.

Holyhead. Aero Marine Limited. Negotiations are taking place with the Council for the erection of a new factory.

Hyde. The Landis Machine Company, Waynesborough, Pennsylvania, U.S.A. who have taken over the works of Maiden & Co. Limited, Alexandra Street, are to extend the factory.

Ilkeston. The Trentham Rubber Company Limited, are to extend their factory in Trowell Avenue.

Leamington Spa. Glass Sealer Company Limited, Garrison Street, Birmingham 9. Extensions are to be made to the factory on Queensway trading estate.

Vibraproof Limited, 38 Trent Street, Birmingham 5 are to make extensions to their factory on the Queensway trading estate.

Lisburn. Northern Ireland Ministry of Commerce is to erect a new factory. The architect is A. F. Lucy, 13 Lombard Street, Belfast.

Liverpool. Brunswick Printers (Liverpool) Limited, Warren Street. New factory to be built at Greek Street, Copperas Hill.

Llanelly. Crawley Industrial Products Limited, 48 Wellesley Road, Croydon. New factory to be built at North Dock.

London. Franco British Electrical Company Limited. Extensions are to be made to the factory at Aerodrome Road, Hendon.

Luton. The factory of Tusroke Engineering Company Limited is to be extended.

Merthyr. Hoover (Washing Machines) Limited, are to make extensions to their factory at Pentrebach.

Morecambe. Morecambe Electrical Equipment Company Limited, Westgate. Factory extensions.

Oswestry. W. F. Crane. New printing works to be built at Coney Green, Salop Road. Architect, G. Whitmore, 5 Church Street.

Redditch. George Birch & Co. Limited, Russell Street, Willenhall. New factory at Beoley Road.

Romford. E. T. Roberts (Soft Sole Shoes) Limited, are to erect a new factory at Lyon Road, South Street.

Scarborough. Plaxton's (Scarborough) Limited, are to make extensions to their Castle Works, Seamer Road. Architects, G. W. Alderson, 4 Pavilion Terrace.

Southall. Cramic Engineering Company Limited. A new factory is to be erected in Bridge Road.

Stevenage. Electro-Methods Limited. Contracts for the erection of a new factory let to D. Chaston Limited, Hoddesdon.

Tamworth. Cincinnati Milling Machines Limited. The contract for the erection of a new factory has been let to A. R. Astbury Limited, Watling Street, Cannock.

Wakefield. W. E. Rawson Limited, Castle Bank Mills, Portobello Road. Factory extensions.

Walsall. Lagrove Precision Engineering Company Limited, Intown. A new factory is to be erected at the Corner of Adams Street and Wolverhampton Street.

CLASSIFIED ADVERTISEMENTS

Classified advertisements are inserted at the rate of 2/9 per line.

Situations Vacant

REPRESENTATIVE EXPERIENCED in selling MACHINE TOOLS and with connections in LONDON and HOME COUNTIES, required by LONDON FIRM. Good prospects for the right man. Write in confidence, stating age and experience to: Box No. BW 10, "Mechanical World", 31 King Street West, Manchester 3.

MAINTENANCE ENGINEER. Preferable with building experience for medium size Company West London. Wood and allied Trades. Applicants interested in hard work and achievement rewarded—others need not apply. Salary according to ability, experience and personality. Minimum £620 p.a. Practical journeyman and sound supervisor required. Incentives/Bonus. Box AW.9. "Mechanical World", 31 King Street West, Manchester 3.

Machinery, Plant and Accessories For Sale

"FRIGIDAIRE" Low Temperature Refrigerators. 49 in.w × 28 in.d × 34 in.h ext. Ex Large National User, suitable A.C. or D.C. Deep Freezing, Storage of Ice Cream, Frozen Foods, etc. Price £40.0.0 each. Domestic Refrigerators, Service Cabinets and Cold Rooms also available. A.R.C., 134 Great Portland Street, London W1. MUSeum 4480.

FANS! ! ! for Dust, fume extraction, air conditioning, compressors, accessories, motors, etc.; at considerably reduced prices. People say—"If only we'd known of you before. . . . Write for very interesting list. Bellangers, 306 Holloway Road, London N7. North 4117.

UNUSED 10-cwt capacity "Morris" Portable Elevating Warehouse Trucks, having platforms 26 in. × 33 in. mounted on steel wheels. PRICE: £15 each, delivered. Thos. W. Ward Limited., Albion Works, Sheffield. Phone: 26311 Ext. 305.

PUMPS for all purposes. R. L. Christansen Limited, Wordesley, Stourbridge. Brierley Hill 7584.

Patents for Sale or License

THE proprietor of British Patent No. 637940, entitled "Tube Coupling Sleeve", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 603659, entitled "Power-lift Attachment for Tractors", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietors of Patent No. 693530, for "Improvements in or relating to Methods of Securing a Pin in a Member". Patent No. 704139 for "Improvements in or relating to Connections between Pins and Bores", desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Company, 28 Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of British Patent No. 590328, entitled "Timing Control For Mechanisms", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE Proprietor of Patent No. 731009 for "Speed-reducing Device for Winches, Chain Lifts and the like" desires to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28 Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of British Patent No. 730675, entitled "Apparatus and Process for forming Helices from Metal Strips, Rods, Bars, Tubes and the Like", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietors of Patent No. 671413 for "Slings for Lifting and Lowering or for Forming Bundles" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Company, 28 Southampton Buildings, Chancery Lane, London WC2.